TSA-IC500

User's Manual

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- This product should be handled like a CMOS semiconductor device. The user must take all precautions to avoid build-up of static electricity while working with this equipment.
- All test and measurement tool including the workbench must be grounded.
- The user/operator must be grounded using the wrist strap.
- The device pins should not be touched with bare hands.

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FIGURES AND TABLES

1. Overview

1.1 Document Overview

This document describes the hardware specifications, software structure, and USB driver installation for TSA-IC500. It describes an example of analog front end circuit design using mounted phototransistor at the end.

1.2 Terms in This Document

This document uses following teams for explaining the hardware specifications and software.

Table 1.1 List of Terms

Term	Description
Smart Analog	Product that analog circuits and features are reconfigurable by software designed for supporting multiple sensors and drivers.
Smart Analog IC	Product that is categorized in above term, but it is a package of an analog circuit.
Smart Analog IC500	Smart Analog IC (reconfigurable circuit type) from Renesas Electronics. Smart Analog IC500 official part number: RAA730500
GUI “Smart Analog Easy Starter”	Development tool for RL78/G1E Stick
E1 emulator	On-chip debugging emulator from Renesas Electronics. This can be used as a flash programmer. (selling separately)
CubeSuite+	Integrated development environment packaging all basic software tools for developing software on microcontrollers form Renesas Electronics.
SA-Designer	Development tool from Renesas Electronics. It generates circuit data as C source code from the analog frontend circuit designs of Smart Analog product.

1.3 Board Features

- Enable to evaluate Smart Analog IC500 (RAA730500) from Renesas Electronics.
- CPU RL78/G1A (R5F10ELEAFB) is mounted for controlling Smart Analog IC500.
- Option to use USB power or external power supply.
- Enable to get illuminance of phototransistor with using “Smart Analog Easy Starter”.
- Extensibility to add sensors.

1.4 Product Overview

The product contains following items.

- TSA-IC500
- Documentations
  This contains some specific notes and downloading URLs for “Smart Analog Easy Starter” and USB driver. Please read this before start using.
- USB cable (Mini-B type)

The pictures of the board are shown below.

Figure 1.1 Board (Front Side)

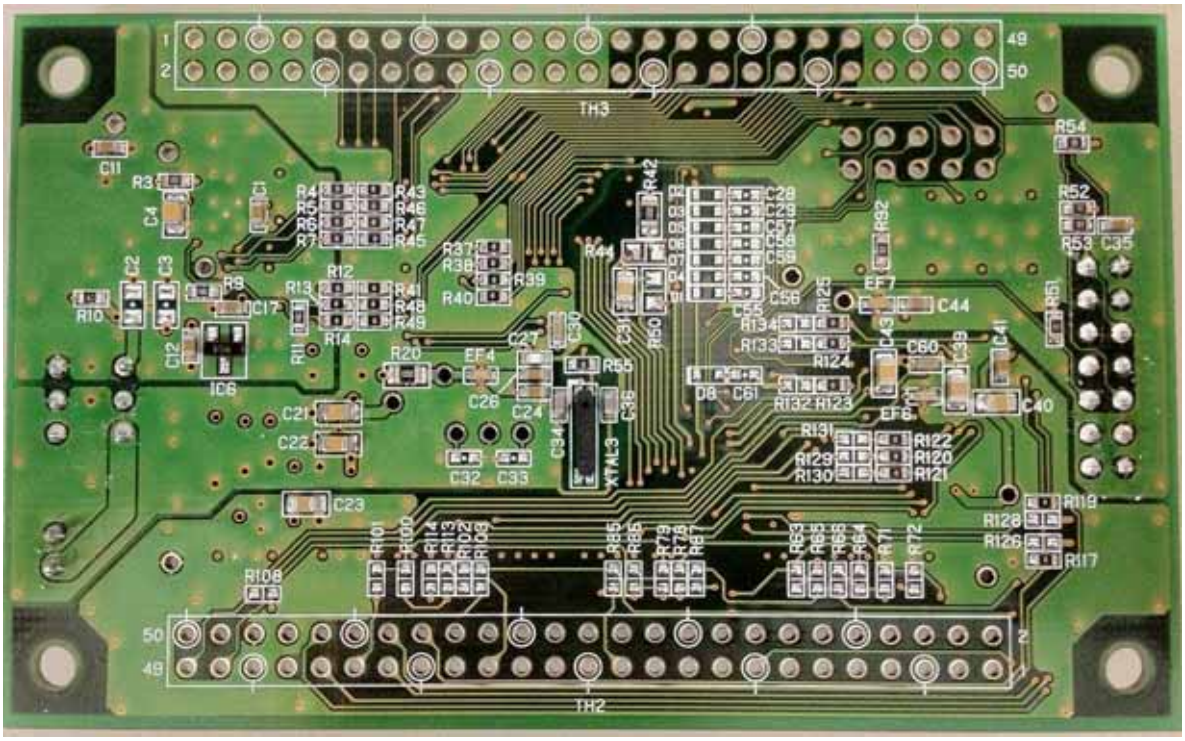


Figure 1.2 Board (Back Side)

The product usage sample is shown below. It can design the analog part of RAA730500 by using “Smart Analog Easy Starter”. Also, you can design with using “CubeSuite+” and “SA-Designer” when you connect E1 emulator. For details about "CubeSuite+" and "SA-Designer" such as operations of them, please refer to Renesas Electronics Web site .

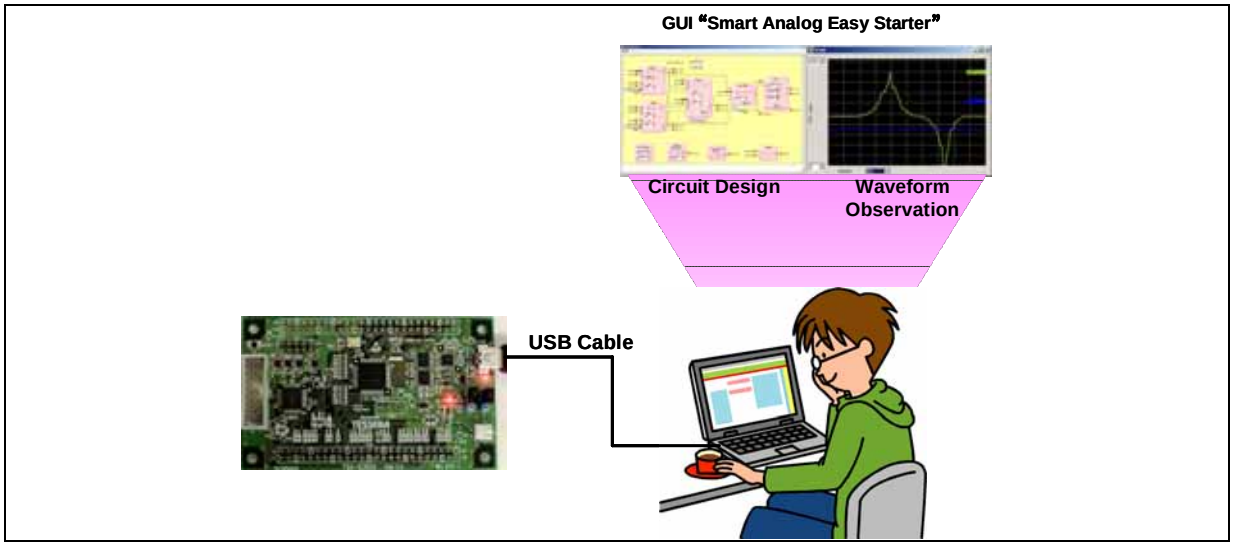


Figure 1.3 Product Usage Sample Image 1

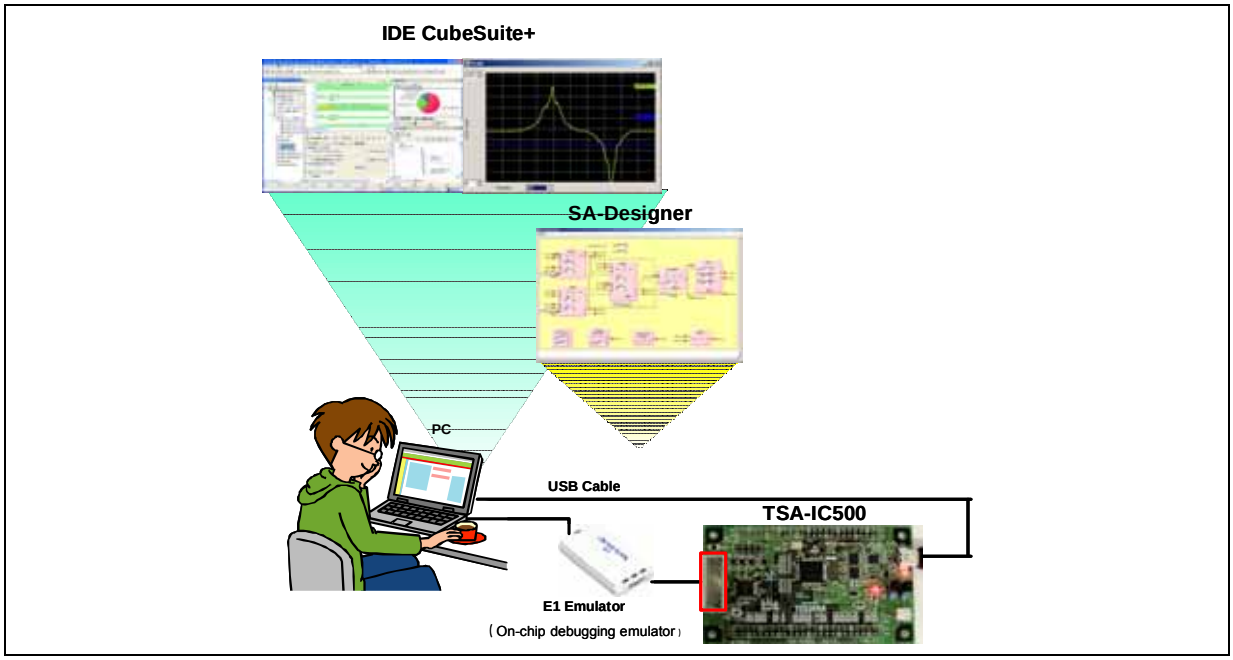


Figure 1.4 Product Usage Sample Image 2

2. Hardware

2.1 Hardware Specifications

The specifications of the product are described in below table.

Table 2.1 Hardware Specifications

Specification	
Smart Analog IC	Smart Analog IC500 (RAA730500) from Renesas Electronics Smart Analog IC, reconfigurable circuit
CPU	RL78/G1A (R5F10ELEAFB) from Renesas Electronics (Flash ROM: 64KB, RAM: 4KB, Data Flash: 4KB)
Operation Frequency	Main system clock: High-speed on-chip oscillator 1-32MHz Low-speed on-chip oscillator 15kHz Sub system clock: Oscillator 32.768kHz
Interface	USB connector (Mini-B) External power connector E1 emulator connector RL78/G1A-Smart Analog IC500 control signal monitor connector Extended sensor I/F connector (50-pin) Extended MCU I/F connector (50-pin)
Sensor Input Terminal	12 terminals: MPXIN10/11/20/21/30/31/40/41/50/51/60/61 It can input up to (A_GND – 0.1V)- (AVCC-1.5V)
Supply Voltage	+5.0V (USB or external power supply)
Indication	LED
Mounted Sensor	Phototransistor (SFH3710-3/4-Z from OSRAM)
Product Size	Board size: 90 x 55 mm (W x D)

2.2 Block Diagram

The block diagram of TSA-IC500 is shown below.

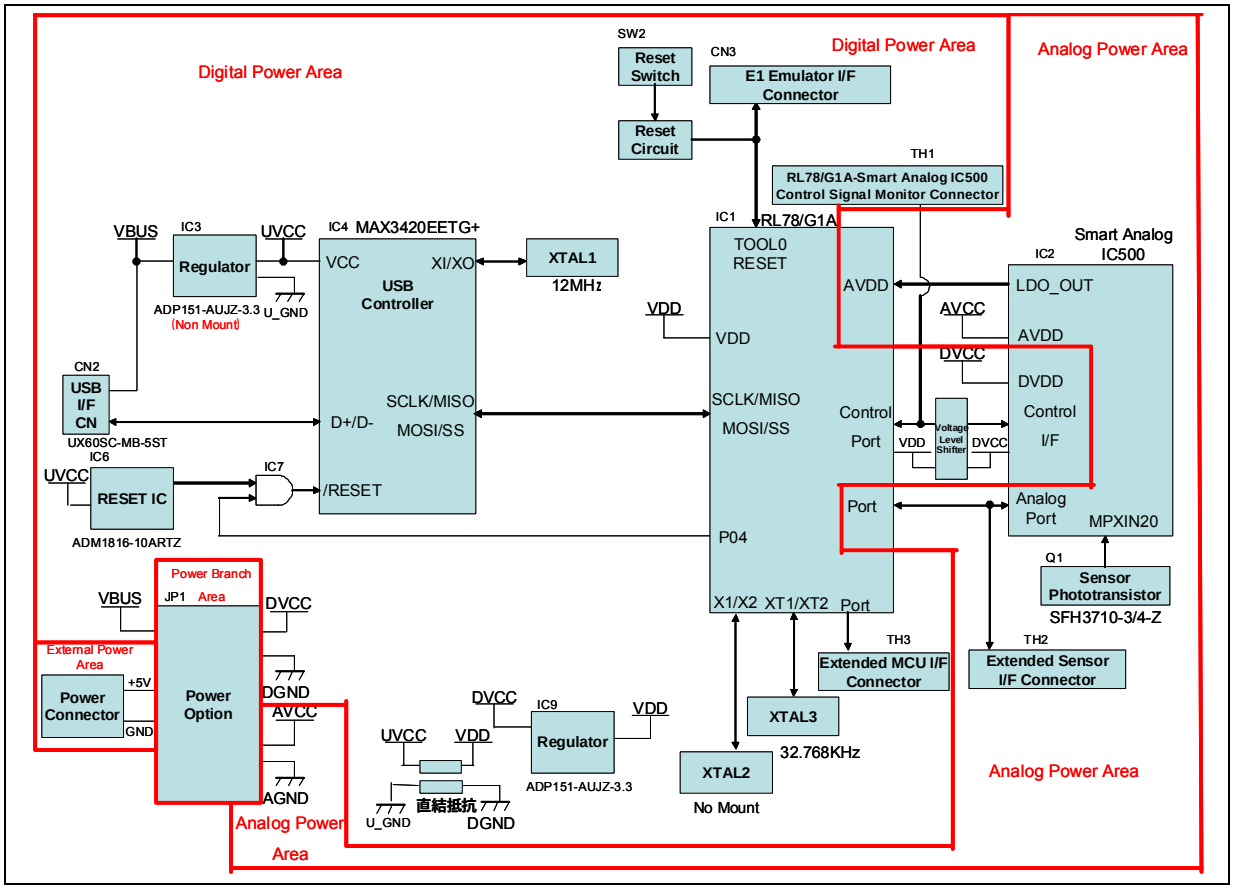


Figure 2.1 TSA-IC500 Block Diagram

This board mounts RL78/G1A for the control microcontroller of Smart Analog IC500. To minimize noises, it uses separate power plane.

- External Power Area:
  Area that supplies DC power from external power.
- Power Branch Area:
  Area that supplies power to digital power area and analog power area with selecting from USB power or external power.
- Digital Power Area:
  Area that supplies power to USB controller, RL78/G1A and logic circuit.
- Analog Power Area:
  Area that supplies power to analog power of Smart Analog IC500 and RL78/G1A.

2.3 Power Supply

2.3.1 Power Options

This board has a function to be able to select a power source. Following table and figure describe how to set a power source. It is set to USB power supply as default.

Table 2.2 Power Supply Settings

Power Source	JP1 Setting	Connector Reference	Connector Form	Connector Part Number
External power supply (+5.0V) *	5-3 short 6-4 short	CN1	2.5mm-pitch dipole connector	B2P-SHF-1AA
USB power supply (+5.0V)	1-3 short 2-4 short	CN2	USB Mini-B connector	UX60SC-MB-5ST

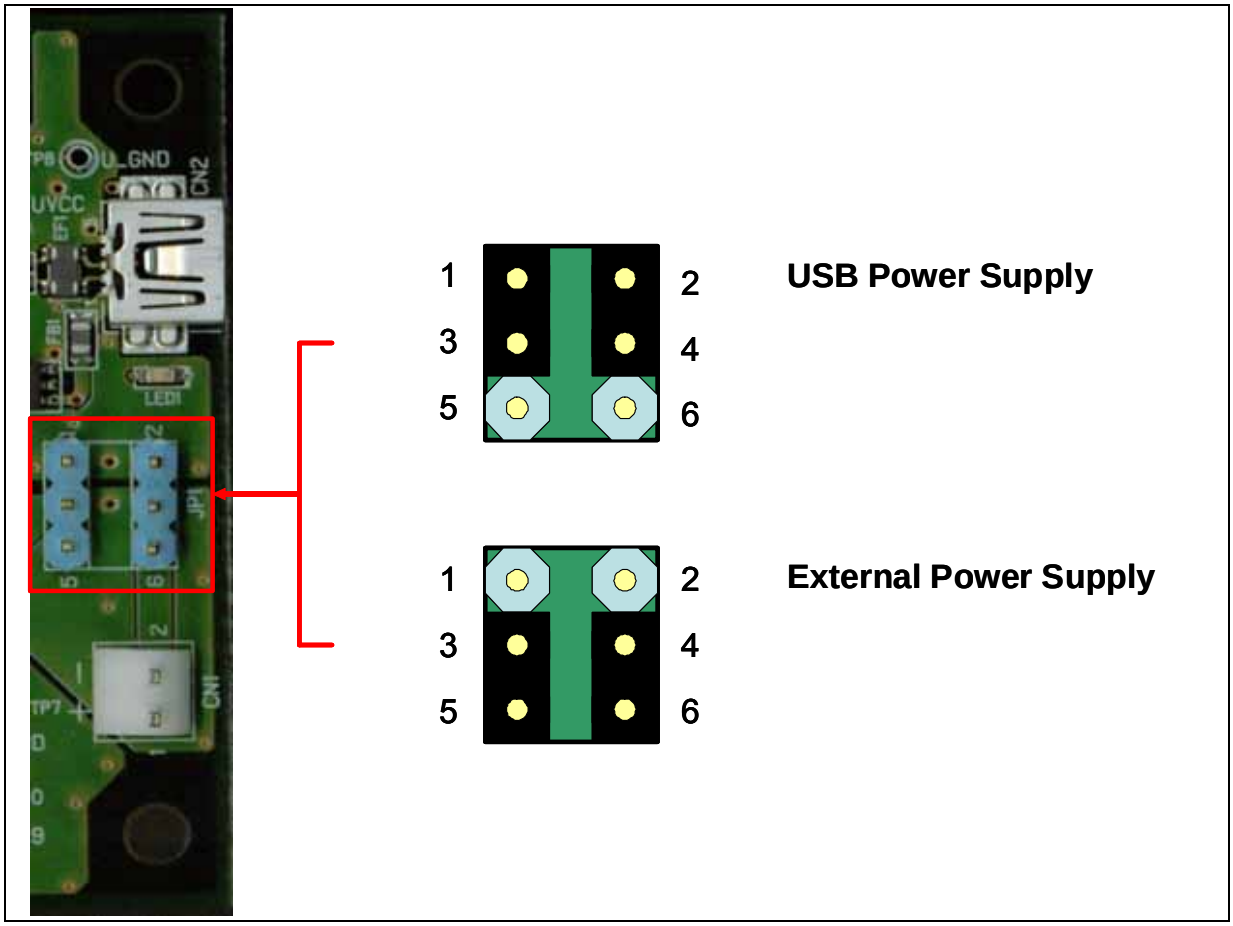


Figure 2.2 JP1 Setting

*Do not apply voltage other than +5.0V. The board is not guaranteed to work.

2.3.2 Supply Power

LED will turn on when you supply power to the board. If it is USB power supply, both LED1 and LED2 will turn on. If it is external power supply, only LED2 will turn on.

Figure 2.3 LED Indicator (USB Power Supply)

Figure 2.4 LED Indicator (External Power Supply)

2.4 Smart Analog IC500

The connecting destinations of all Smart Analog IC500 terminals are described below.

Table 2.3 Smart Analog IC500 Terminal List

Smart Analog IC500 Pin No.	Smart Analog IC500 Terminal Name	Circuit Signal Name	Destination 1	Destination 2
1	AVDD3	AVCC	Analog power	-
2	SC_IN	UMBL_SCIN	Extended sensor I/F connector	-
3	CLK_SYNCH	SAIC_CLKSYNCH	RL78/G1A P41 (4pin) through Level Shifter	-
4	SYNCH_OUT	UMBL_SYNCOUT	Extended sensor I/F connector	RL78/G1A ANI19 (1pin)
5	AGND2	A_GND	Analog power	-
6	GAINAMP_OUT	UMBL_GAMPOUT	Extended sensor I/F connector	RL78/G1A ANI16 (59pin)
7	GAINAMP_IN	UMBL_GAMPIN	Extended sensor I/F connector	-
8	MPXIN61	UMBL_MPXIN61	Extended sensor I/F connector	Amp peripheral circuit
9	MPXIN51	UMBL_MPXIN51	Extended sensor I/F connector	Amp peripheral circuit
10	MPXIN60	UMBL_MPXIN60	Extended sensor I/F connector	Amp peripheral circuit
11	MPXIN50	UMBL_MPXIN50	Extended sensor I/F connector	Amp peripheral circuit
12	AMP3_OUT	UMBL_AMP3OUT	Extended sensor I/F connector	RL78/G1A ANI2 (54pin)
13	DAC3_OUT / VREFIN3	UMBL_DAC3OUT	Extended sensor I/F connector	-
14	AMP2_OUT	UMBL_AMP2OUT	Extended sensor I/F connector	RL78/G1A ANI6 (50pin)
15	AGND1	A_GND	Analog power	-
16	AMP1_OUT	UMBL_AMP1OUT	Extended sensor I/F connector	RL78/G1A ANI7 (49pin)
17	AVDD1	AVCC	Analog power	-
18	DAC2_OUT / VREFIN2	UMBL_DAC2OUT	Extended sensor I/F connector	-
19	DAC1_OUT / VREFIN1	UMBL_DAC1OUT	Extended sensor I/F connector	-
20	MPXIN41	UMBL_MPXIN41	Extended sensor I/F connector	-
21	MPXIN31	UMBL_MPXIN31	Extended sensor I/F connector	-
22	MPXIN40	UMBL_MPXIN40	Extended sensor I/F connector	-
23	MPXIN30	UMBL_MPXIN30	Extended sensor I/F connector	-
24	MPXIN21	UMBL_MPXIN21	Extended sensor I/F connector	-
25	MPXIN11	UMBL_MPXIN11	Extended sensor I/F connector	-
26	MPXIN20	UMBL_MPXIN20	Extended sensor I/F connector	-
27	MPXIN10	UMBL_MPXIN10	Extended sensor I/F connector	-
28	AGND3	A_GND	Analog power	-
29	BGR_OUT	BGR_OUT	Grounded through C42 (0.1uF)	-
30	AVDD2	AVCC	Analog power	-
31	LDO_OUT	UMBL_VREFOUT	Extended sensor I/F connector	RL78/G1A AVDD (47pin) through EF5
32	AMP4_OUT	UMBL_AMP4OUT	Extended sensor I/F connector	RL78/G1A ANI5 (51pin)
33	AMP4_INN	UMBL_AMP4_IN_NE	Extended sensor I/F connector	-
34	AMP4_INP	UMBL_AMP4_IN_PO	Extended sensor I/F connector	-
35	TEMP_OUT	UMBL_TMPOUT	Extended sensor I/F connector	RL78/G1A ANI17 (60pin)
36	RESET	SAIC_/RESET	RL78/G1A-Smart Analog IC500 control signal monitor connector through Level Shifter	RL78/G1A P130 (57pin)

37	DVDD	DVCC	Digital power	-
38	SCLK	SAIC_SCLK	RL78/G1A-Smart Analog IC500 control signal monitor connector through Level Shifter	RL78/G1A SCK21 (29pin)
39	SDO	UMBL_SDO	RL78/G1A-Smart Analog IC500 control signal monitor connector	RL78/G1A SI21 (28pin)
40	SDI	SAIC_SDI	RL78/G1A-Smart Analog IC500 control signal monitor connector through Level Shifter	RL78/G1A SO21 (27pin)
41	CS	SAIC_/CS	RL78/G1A-Smart Analog IC500 control signal monitor connector through Level Shifter	RL78/G1A P73 (26pin)
42	DGND	D_GND	Digital power	-
43	DAC4_OUT / VREFIN4	UMBL_DAC4OUT	Extended sensor I/F connector	-
44	HPF_OUT	UMBL_HPFOUT	Extended sensor I/F connector	RL78/G1A ANI4 (52pin)
45	CLK_HPF	SAIC_CLKHPF	RL78/G1A TO00 (61pin) through Level Shifter	-
46	CLK_LPF	SAIC_CLKLPF	RL78/G1A TO04 (3pin) through Level Shifter	-
47	AGND4	A_GND	Analog power	-
48	LPF_OUT	UMBL_LPFOUT	Extended sensor I/F connector	RL78/G1A ANI3 (53pin)

2.5 Evaluation Circuit

This section describes the evaluation circuit on the board.

2.5.1 Switch

The board has 2 kinds of switches shown below table.

Table 2.4 Switch Functions

Reference	Function
SW1	Switch for external interrupts Connecting to INTP0 terminal of RL78/G1A Inputting High level to INTP0 terminal when releasing the switch, and Low level when pushing down the switch.
SW2	Switch for board reset Connecting to RESET terminal of RL78/G1A Inputting High level to RESET terminal when releasing the switch, and Low level when pushing down the switch. MCU becomes reset status when Low level.

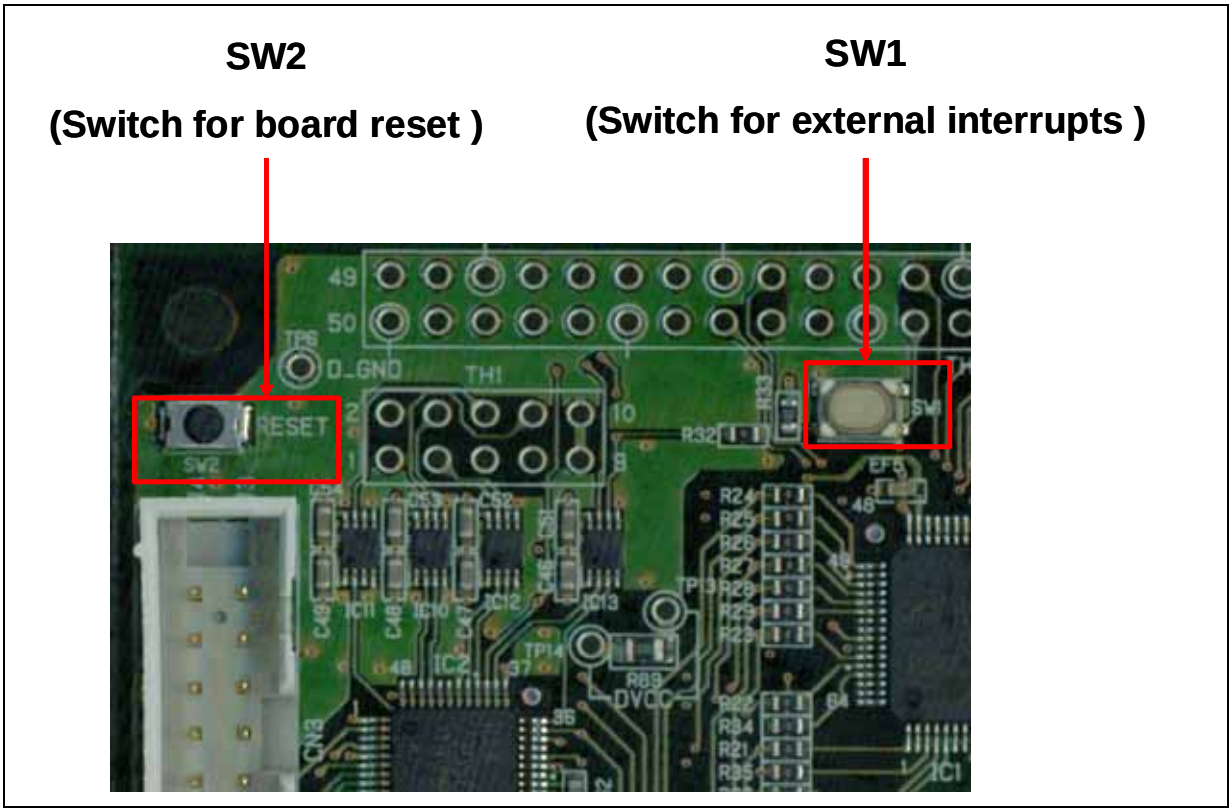


Figure 2.5 Switch Layout

2.5.2 Clock Circuit

RL78/G1A, mounted on this board, has a high-speed oscillator built-in as system clock. This board does not have a normal oscillator since use of high-speed built-in oscillator circuit is assumed. The pattern (XTAL2) is built on the board in case that frequency accuracy and frequency itself cannot meet the requirements. Lead type two/three terminal oscillator can be implemented. Also, XTAL3 (32.768kHz) is mounted as a sub clock.

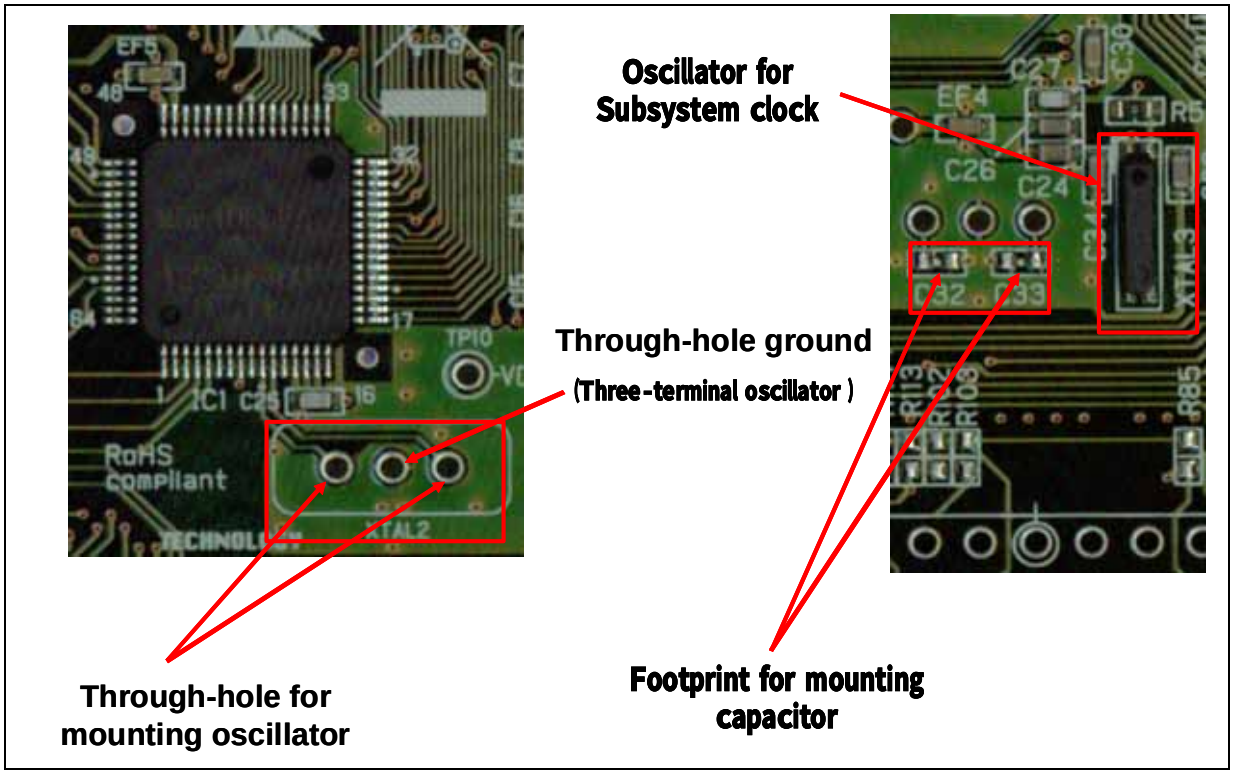


Figure 2.6 Clock Circuit Layout

2.5.3 Consumption Current Measurement Terminal

There are measurement terminals on the board to measure consumption current for RL78/G1A and Smart Analog IC500. Disconnect 0Ω resistance (R20/R60/R89) before measuring the consumption current.

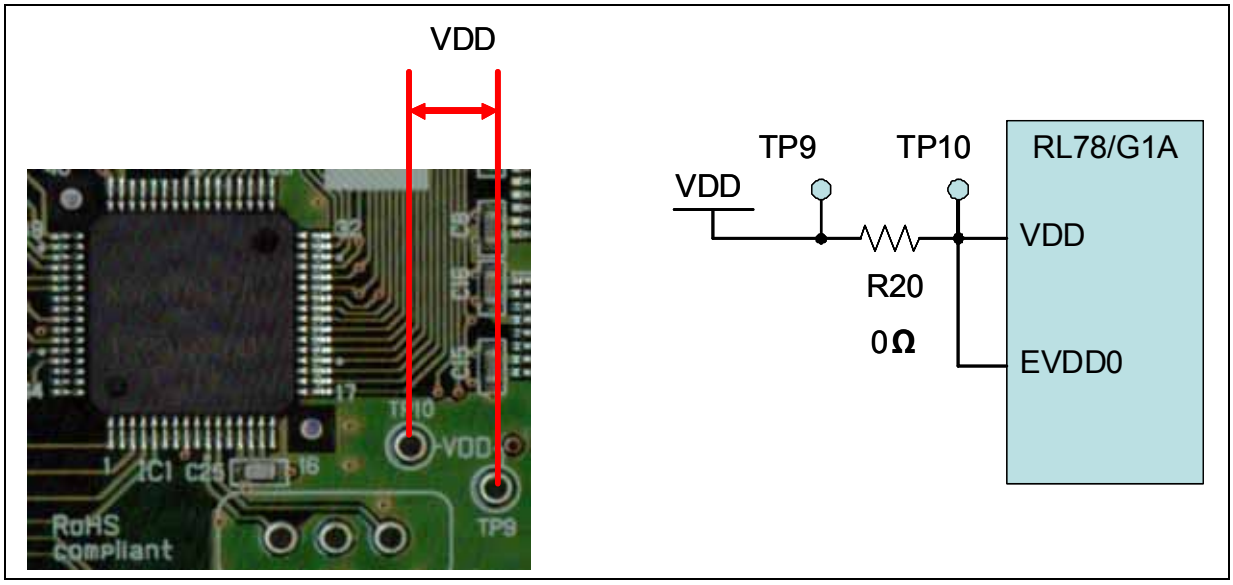


Figure 2.7 RL78/G1A Current Measurement Terminal

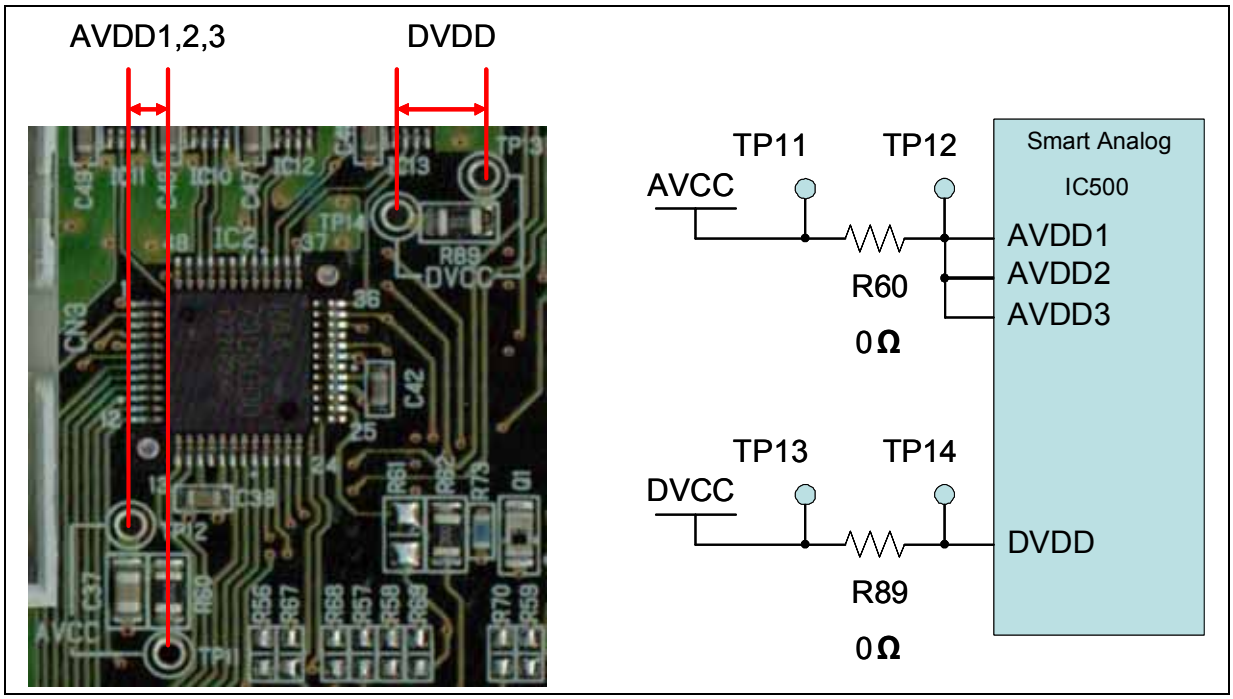


Figure 2.8 Smart Analog IC500 Current Measurement Terminal

2.5.4 Smart Analog IC500 Analog Peripheral Circuit

Smart Analog IC500 on the board has an operational amplifier, which has a resistance built-in for variable gain. Also, patterns are designed on the board for the case of connecting other parts. The size of a resistance should be 1608. Those resistances without constant mean that they are not mounted.

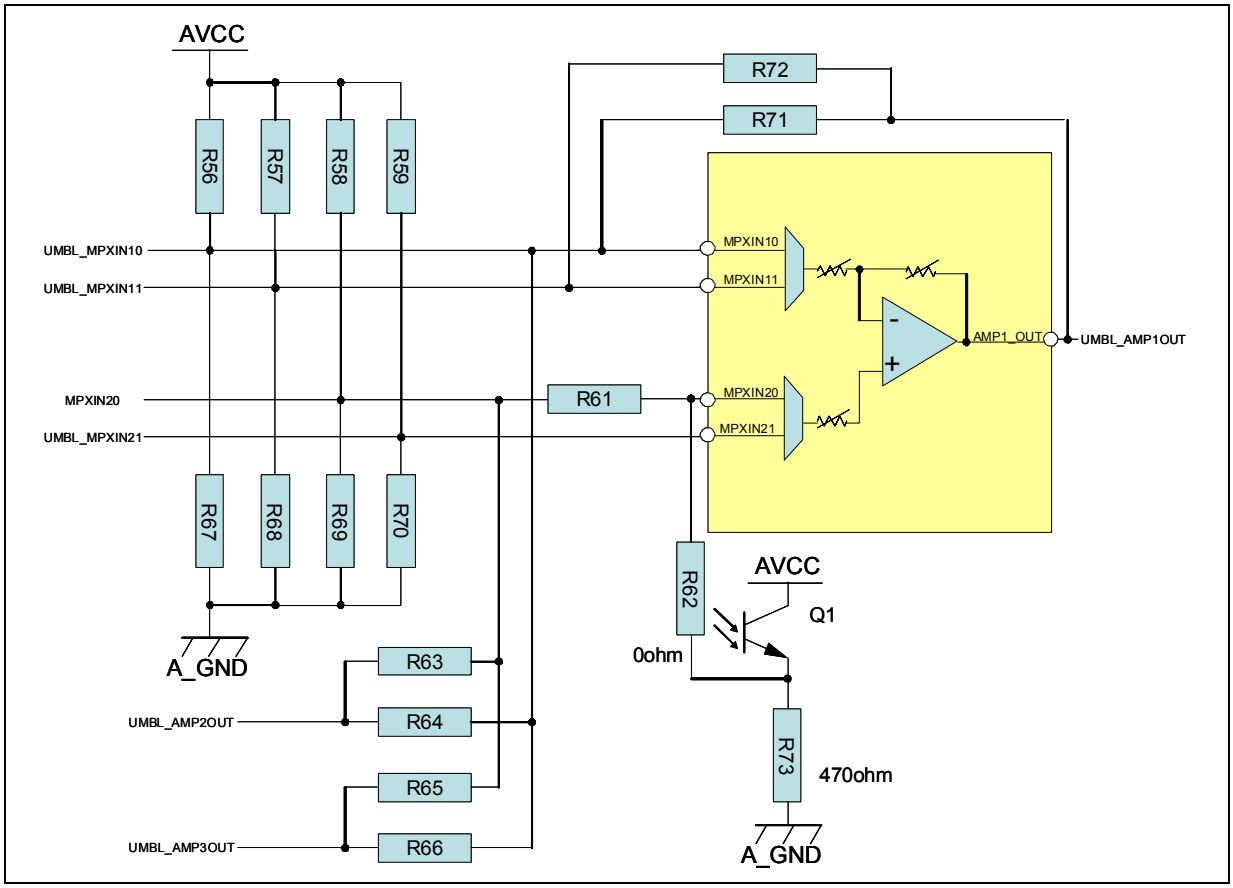


Figure 2.9 Amplifier Peripheral Circuit 1: AMP1

* Caution:
A phototransistor is connected to the input terminal MPXIN20 in the built-in operational amplifier AMP1. To connect other sensor, please disconnect R62. Mount the disconnected resistance to R61.

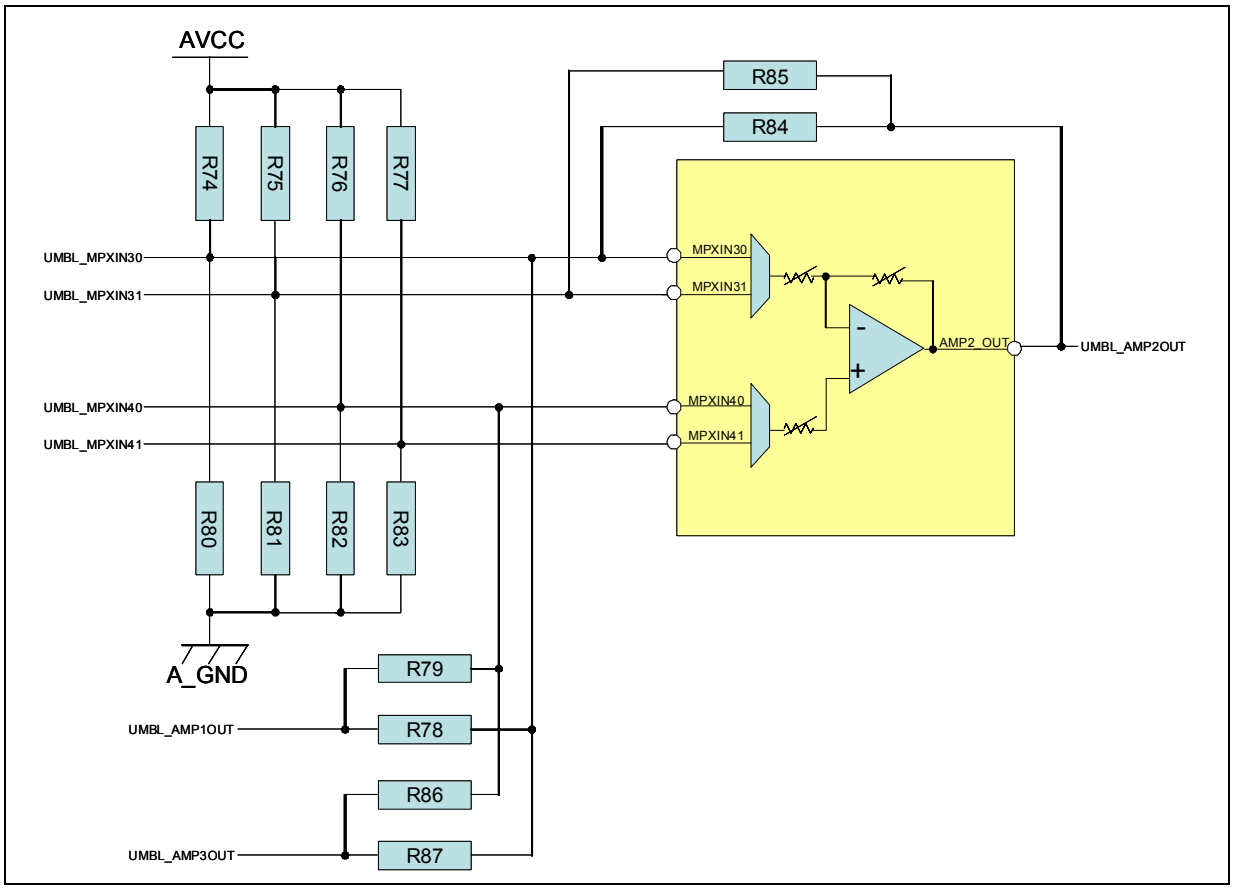


Figure 2.10 Amplifier Peripheral Circuit 2: AMP2

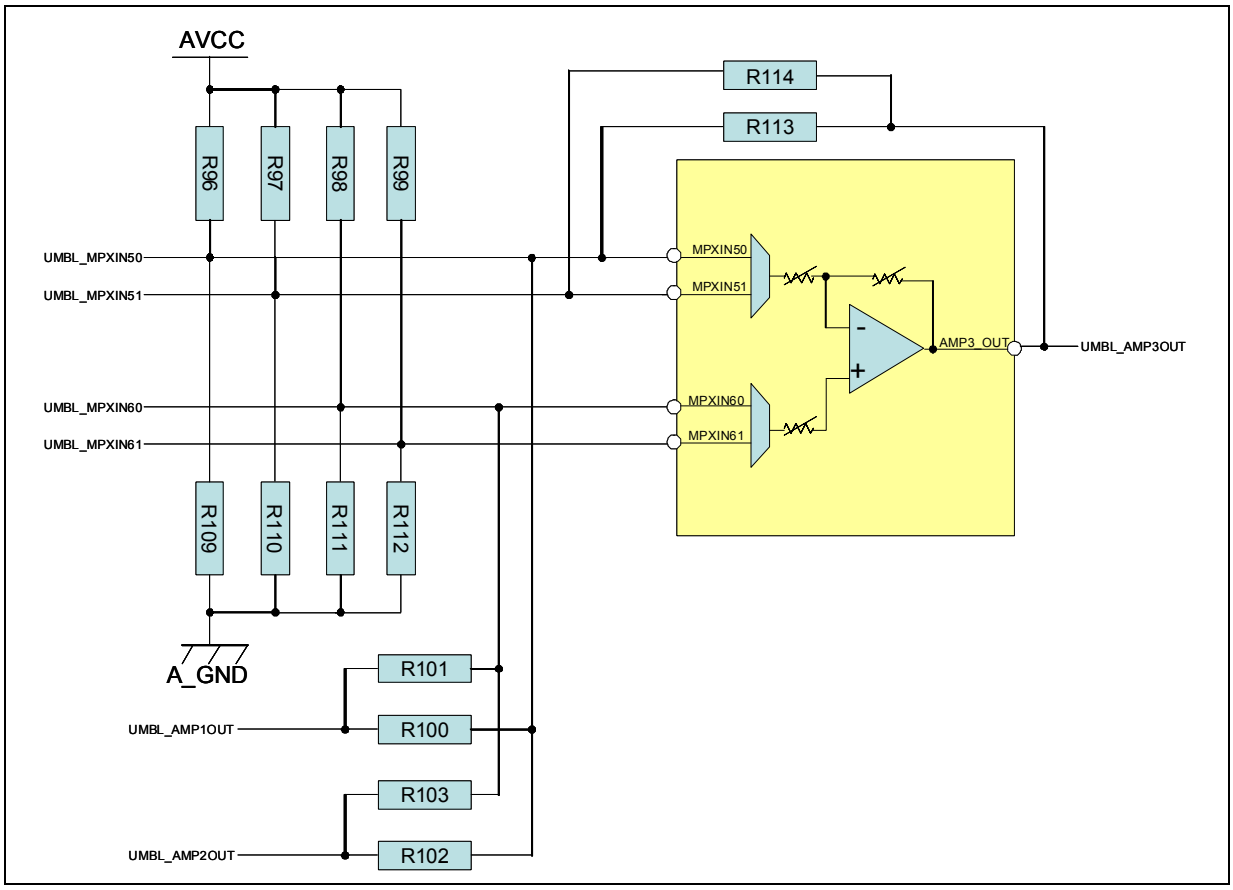


Figure 2.11 Amplifier Peripheral Circuit 3: AMP3

Analog signal of Smart Analog IC500 is connected to the input terminal of A/D converter in RL78/G1A. The pattern is mounted to be able to connect parts between Smart Analog IC500 and RL78/G1A. The size of parts should be 1608. A voltage-dividing resistance circuit and clamp circuit can be mounted.

The patterns in below figure are mounted on Smart Analog IC500 terminals in below table. Those resistances without constant mean that they are not mounted.

Smart Analog IC500 Terminal	Reference Cx	Reference Dx	Reference Rx	Reference Ry	Reference Rz
AMP1_OUT	C28	D2	R24	R120	R129
AMP2_OUT	C29	D3	R25	R121	R130
AMP3_OUT	C56	D4	R29	R122	R131
AMP4_OUT	C57	D5	R26	R123	R132
HPF_OUT	C58	D6	R27	R124	R133
LPF_OUT	C59	D7	R28	R125	R134
GAINAMP_OUT	C55	D1	R23	R119	R128
SYNCH_OUT	C61	D8	R21	R117	R126

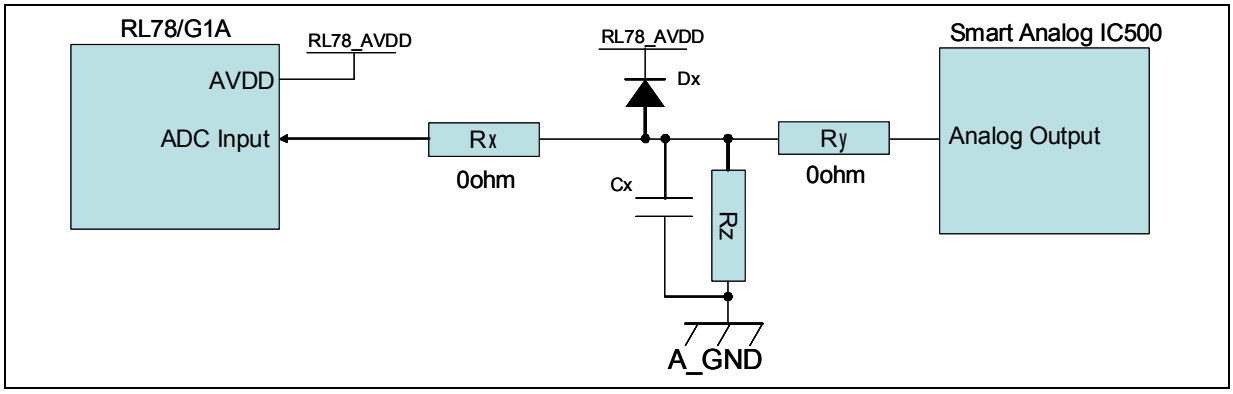


Figure 2.12 Amplifier Peripheral Circuit 4

With the ADC limitation of RL78/G1A, the maximum voltage that can apply to ADC is 3.3V. The analog terminal of Smart Analog IC500 can output maximum of 5V. Because of this, the pattern is mounted to be able to connect parts between Smart Analog IC500 and RL78/G1A, and a voltage-dividing circuit can be mounted. As an example, the formula, for evaluating the analog voltage from the analog terminal of Smart Analog IC500 when a voltage-dividing resistance is mounted, is described below.

The formula to evaluate analog voltage from A/D conversion value (A/D conversion value register (ADCR 12bit)) is shown below.

$$\text{Analog Voltage1} = \frac{\text{A/D conversion value}}{2^{12} - 1} \times \text{RL78\_AVDD}$$

Analog Voltage1: A/D converter input voltage (V)
RL78_AVDD: A/D converter power voltage (V)

Analog Voltage1 divides output voltage from the analog terminal of Smart Analog IC500 by resistance. Thus, following formula describes the output voltage of analog terminal.

$$\text{Analog Voltage2} = \text{Analog Voltage1} \times \frac{(\text{Ry} + \text{Rz})}{\text{Rz}}$$

Analog Voltage2: Output voltage (V) from analog terminal of Smart Analog IC500

In practice, the effect of resistance errors should be taken into consideration in above formula.

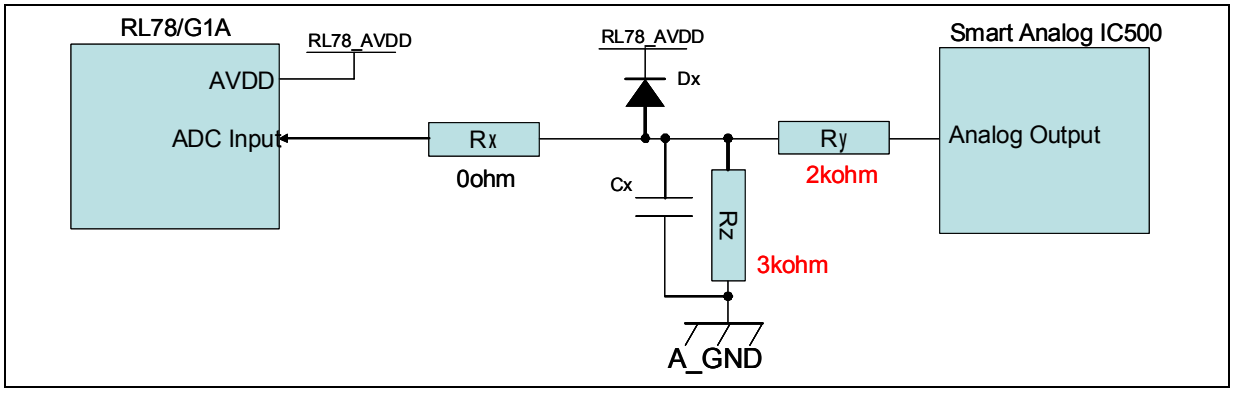


Figure 2.13 Example of Mounting Resistance for Voltage-dividing Circuit to Amplifier Peripheral Circuit 4

Smart Analog IC500 terminal mounts patterns shown below figure.

- TEMP_OUT

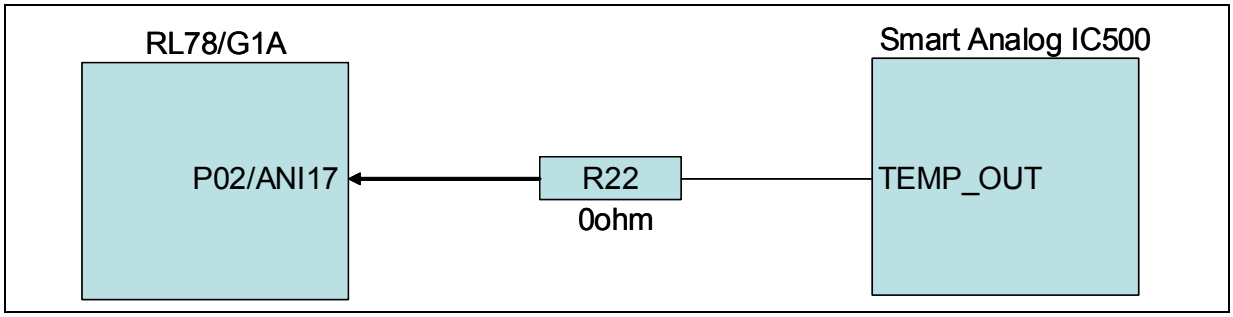


Figure 2.14 Amplifier Peripheral Circuit 5

Smart Analog IC500 terminal mounts patterns shown below figure. RL78/G1A and Smart Analog IC500 are connected through a level-shifter with two power supply type to accept the voltage error between them.

- CLK_HPF
- CLK_LPF
- CLK_SYNCH

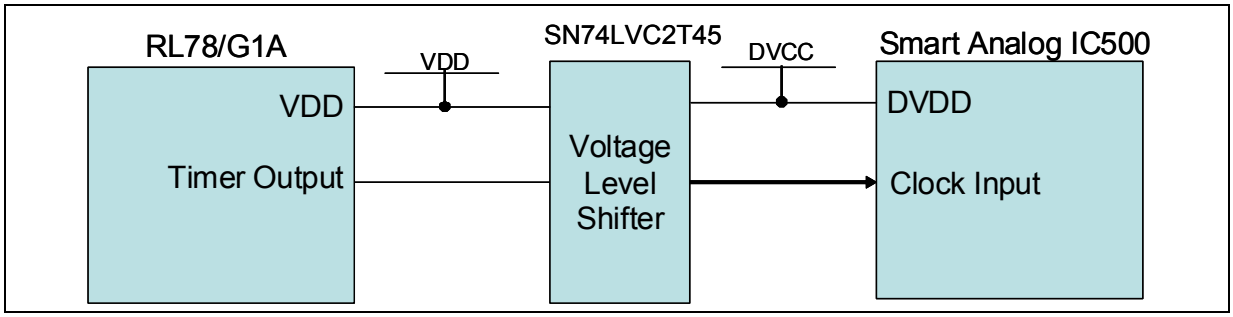


Figure 2.15 Amplifier Peripheral Circuit 6

2.5.5 Connector

The board mounts many kinds of connectors. (Some parts are not mounted.) The table below describes the connectors.

Table 2.5 Connector Function List

Connector Reference	Connector Form	Connector Part Name	Function
CN1	2.5mm-pitch dipole connector	B2P-SHF-1AA	External power supply (+5.0V apply)
CN2	USB Mini-B connector	UX60SC-MB-5ST	USB I/F
CN3	2.54mm-pitch 14-pole connector	7614-6002PL	E1 emulator I/F
TH1	2.54mm-pitch 10-pole connector	Not mounted	RL78/G1A - Smart Analog IC500 control signal monitor
TH2	2.54mm-pitch 50-pole connector	Not mounted	Extended sensor I/F
TH3	2.54mm-pitch 50-pole connector	Not mounted	Extended MCU I/F

2.5.5.1 External Power Supply Connector

As an external power supply connector, CN1 is mounted. Apply +5.0V with caring about plus and minus. For detail about selecting power sources from external power or USB power, please refer to “2.3.1 Power Options”.

Figure 2.16 External Power Supply Connector Layout

2.5.5.2 USB I/F Connector

As an USB I/F connector, CN2 is mounted. It is connected to PC through USB controller (MAX3420). The cable is bundled, so please use it. For detail about selecting power sources from external power or USB power, please refer to “2.3.1 Power Options”.

Figure 2.17 USB I/F Connector Layout

2.5.5.3 E1 Emulator I/F Connector

As an E1 Emulator I/F connector, CN3 is mounted. With E1 emulator connected, you can debug and program software. For details, please refer to “3.1Tutorial for SA-Designer and CubeSuite+”.

Figure 2.18 E1 Emulator I/F Connector Layout

* Caution:
Do not supply power from E1 emulator. It may cause the board breakdown.

2.5.5.4 RL78/G1A - Smart Analog IC500 Control Signal Monitor Connector

As a RL78/G1A - Smart Analog IC500 Control Signal Monitor connector, TH1 is mounted. The parts are not mounted for TH1. Instead, through-holes are mounted for a flexible usage. They can be used for monitoring the control signals between RL78/G1A and Smart Analog IC500 or for controlling Smart Analog IC500 from CPU directly. When controlling Smart Analog IC500 from external CPU, process the control signal of RL78/G1A on the board appropriately.

Table 2.6 RL78/G1A - Smart Analog IC500 Control Signal Monitor Connector

TH1	Smart Analog IC500		Signal Name on Circuit Diagram	Connection with RL78/G1A
Pin No.	Terminal No.	Signal Name		
1	38	SCLK	UMBL_SCLK	To 29-Pin SCK21
2	39	SDO	UMBL_SDO	To 28-Pin SI21
3	40	SDI	UMBL_SDI	To 27-Pin SO21
4	41	CS	UMBL_CS	To 26-Pin P73
5	36	RESET	UMBL_RESET	To 57-Pin P130
6	3	CLK_SYNCH	UMBL_CLKSYNC	To 4-Pin TO07
7	46	CLK_LPF	UMBL_CLKLPF	To 3-Pin TO04
8	45	CLK_HPF	UMBL_CLKHPF	To 61-Pin TO00
9	-		D_GND	-
10	-		D_GND	-

The red frame parts below are connected to TH1.

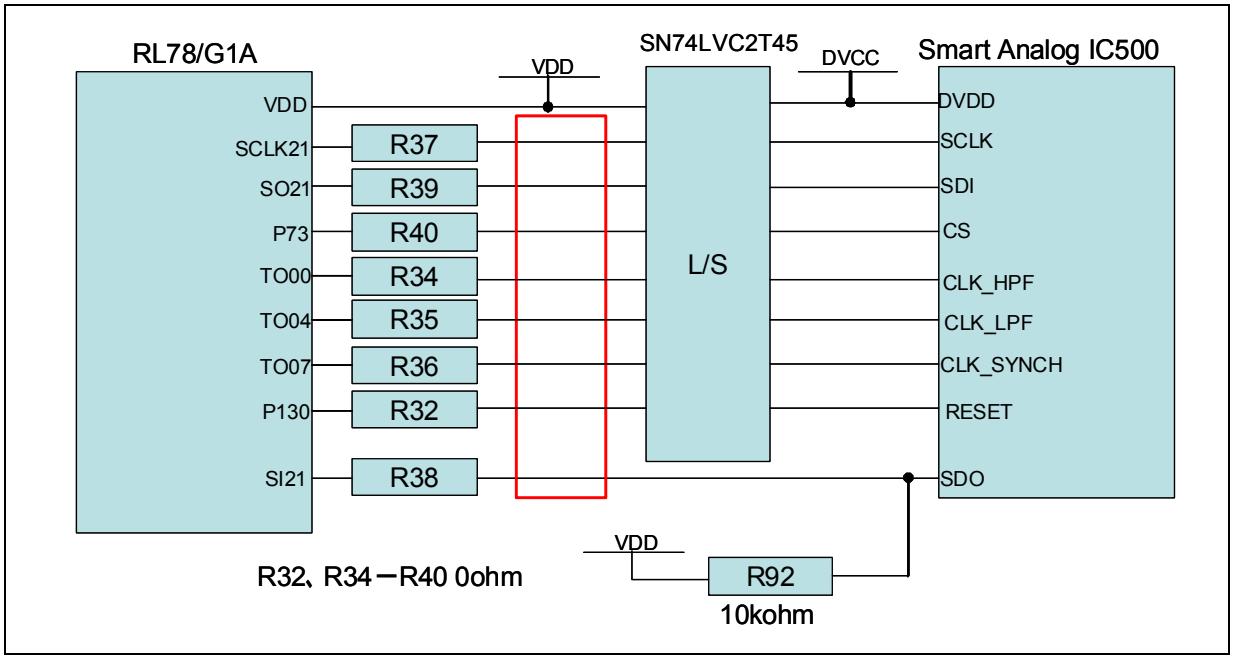


Figure 2.19 RL78/G1A - Smart Analog IC500 Control Signal Monitor Connector Circuit

Figure 2.20 RL78/G1A - Smart Analog IC500 Control Signal Monitor Connector Layout

2.5.5.5 Extended Sensor I/F Connector

As an extended sensor I/F connector, TH2 is mounted. The parts are not mounted for TH2. Instead, through-holes are mounted for a flexible usage.

Table 2.7 Extended Sensor I/F Connector

TH2	Smart Analog IC500		Signal Name on Circuit Diagram	TH2	Smart Analog IC500		Signal Name on Circuit Diagram
Pin No.	Terminal No.	Signal Name		Pin No.	Terminal No.	Signal Name	
1	19	DAC1OUT	UMBL_DAC1OUT	2	-		AVCC
3	16	AMP1OUT	UMBL_AMP1OUT	4	-		A_GND
5	-		A_GND	6	-		A_GND
7	27	MPXIN10	UMBL_MPXIN10	8	-		No connection
9	25	MPXIN11	UMBL_MPXIN11	10	-		No connection
11	26	MPXIN20	UMBL_MPXIN20	12	-		No connection
13	24	MPXIN21	UMBL_MPXIN21	14	-		RL78_AVDD
15	18	DAC2OUT	UMBL_DAC2OUT	16	-		RL78_AVREFP
17	14	AMP2OUT	UMBL_AMP2OUT	18	-		RL78_AVREFM
19	-		A_GND	20	-		RL78_ANI8
21	23	MPXIN30	UMBL_MPXIN30	22	-		RL78_ANI9
23	21	MPXIN31	UMBL_MPXIN31	24	-		RL78_ANI10
25	22	MPXIN40	UMBL_MPXIN40	26	-		RL78_ANI11
27	20	MPXIN41	UMBL_MPXIN41	28	-		RL78_ANI12
29	13	DAC3OUT	UMBL_DAC3OUT	30	35	TEMP_OUT	UMBL_TMPOUT
31	12	AMP3OUT	UMBL_AMP3OUT	32	44	HPF_OUT	UMBL_HPFOUT
33	-		A_GND	34	48	LPF_OUT	UMBL_LPFOUT
35	11	MPXIN50	UMBL_MPXIN50	36	4	SYNCH_OUT	UMBL_SYNCOUT
37	9	MPXIN51	UMBL_MPXIN51	38	6	GAINAMP_OUT	UMBL_GAMPOUT
39	10	MPXIN60	UMBL_MPXIN60	40	2	SC_IN	UMBL_SCIN
41	8	MPXIN61	UMBL_MPXIN61	42	7	GAINAMP_IN	UMBL_GAMPIN
43	33	AMP4_INN	UMBL_AMP4OUT_IN_NE	44	31	LDO_OUT	UMBL_VREFOUT
45	34	AMP4_INP	UMBL_AMP4OUT_IN_PO	46	-		A_GND
47	43	DAC4OUT	UMBL_DAC4OUT	48	-		A_GND
49	32	AMP4_OUT	UMBL_AMP4OUT	50	-		AVCC

Figure 2.21 Extended Sensor I/F Connector Layout

We are selling the sensor extension board. This board is connected to Extended Sensor I/F Connector(TH2). Pin header is included with the board. Please mount the TH2 this pin header. Should be implemented in the same plane as the CN3(E1 Emulator I/F Connector). You can be extension by a sensor used in combination with TSA-IC500 as in TSA-EXT BOARD.

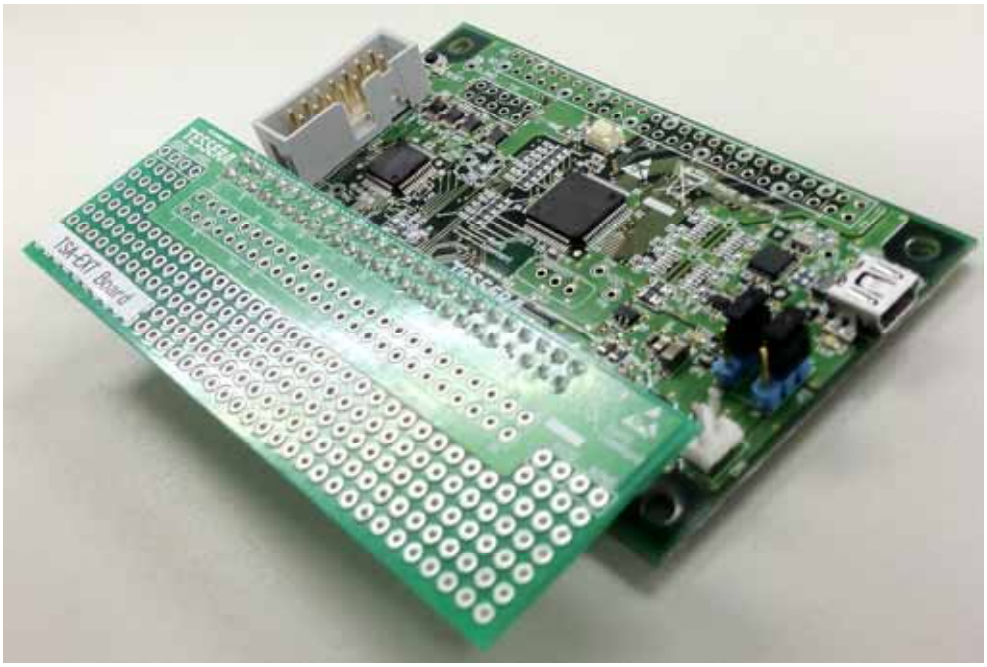


Figure 2.22 TSA-IC500 connecting the sensor extension board TSA-EXT BOARD

* TSA-EXT BOARD is not attached to the TSA-IC500. Please purchase separately.

It is a list of connecting signal TSA-EXT BOARD and TSA-IC500.

TSA-IC500			TSA-EXT BOARD		TSA-IC500			TSA-EXT BOARD	
TH2	Smart Analog IC500				TH2	Smart Analog IC500			
Pin	Pin	Signal			Pin	Pin	Signal		
1	19	DAC1OUT	CN1-1	TH1-1	2	Analog Power		CN1-2	TH1-2
3	16	AMP1OUT	CN1-3	TH1-3	4	Analog GND		CN1-4	TH1-4
5	Analog GND		CN1-5	TH1-5	6	Analog GND		CN1-6	TH1-6
7	27	MPXIN10	CN1-7	TH1-7	8	N.C		CN1-8	TH1-8
9	25	MPXIN11	CN1-9	TH1-9	10	N.C		CN1-10	TH1-10
11	26	MPXIN20 *	CN1-11	TH1-11	12	N.C		CN1-12	TH1-12
13	24	MPXIN21	CN1-13	TH1-13	14	- (RL78_AVDD) **		CN1-14	TH1-14
15	18	DAC2OUT	CN1-15	TH1-15	16	- (RL78_AVREFP) **		CN1-16	TH1-16
17	14	AMP2OUT	CN1-17	TH1-17	18	- (RL78_AVREFM) **		CN1-18	TH1-18
19	Analog GND		CN1-19	TH1-19	20	- (RL78_ANI8) **		CN1-20	TH1-20
21	23	MPXIN30	CN1-21	TH1-21	22	- (RL78_ANI9) **		CN1-22	TH1-22
23	21	MPXIN31	CN1-23	TH1-23	24	- (RL78_ANI10) **		CN1-24	TH1-24
25	22	MPXIN40	CN1-25	TH1-25	26	- (RL78_ANI11) **		CN1-26	TH1-26
27	20	MPXIN41	CN1-27	TH1-27	28	- (RL78_ANI12) **		CN1-28	TH1-28
29	13	DAC3OUT	CN1-29	TH1-29	30	35	TEMP_OUT	CN1-30	TH1-30
31	12	AMP3OUT	CN1-31	TH1-31	32	44	HPF_OUT	CN1-32	TH1-32
33	Analog GND		CN1-33	TH1-33	34	48	LPF_OUT	CN1-34	TH1-34
35	11	MPXIN50	CN1-35	TH1-35	36	4	SYNCH_OUT	CN1-36	TH1-36
37	9	MPXIN51	CN1-37	TH1-37	38	6	GAINAMP_OUT	CN1-38	TH1-38
39	10	MPXIN60	CN1-39	TH1-39	40	2	SC_IN	CN1-40	TH1-40
41	8	MPXIN61	CN1-41	TH1-41	42	7	GAINAMP_IN	CN1-42	TH1-42
43	33	AMP4_INN	CN1-43	TH1-43	44	31	LDO_OUT	CN1-44	TH1-44
45	34	AMP4_INP	CN1-45	TH1-45	46	Analog GND		CN1-46	TH1-46
47	43	DAC4OUT	CN1-47	TH1-47	48	Analog GND		CN1-48	TH1-48
49	32	AMP4_OUT	CN1-49	TH1-49	50	Analog Power		CN1-50	TH1-50

* Phototransistor is in the initial state are connected. Please implement by replacing the resistors R61/R62 MPXIN20 If you are using on this board.

** This signal is connected to the microcomputer RL78/G1A.

2.5.5.6 Extended MCU I/F Connector

As an extended MCU I/F connector, TH3 is mounted. The parts are not mounted for TH3. Instead, through-holes are mounted for a flexible usage.

Table 2.8 Extended MCU I/F Connector

TH3 Pin	RL78/G1A Connecting Destination		Signal Name	TH3 Pin	RL78/G1A Connecting Destination		Signal Name
1	-		D_GND	2	-		D_GND
3	23	P76	RL78_P76	4	22	P77	RL78_P77
5	28	P71	RL78_SI21	6	27	P72	RL78_SO21
7	32	P30	RL78_P30	8	29	P70	RL78_SCK21
9	58	P04	RL78_P04	10	-		No connection
11	2	P43	RL78_P43	12	3	P42	RL78_P42
13	35	P16	RL78_P16	14	36	P15	RL78_P15
15	37	P14	RL78_P14	16	38	P13	RL78_P13
17	39	P12	RL78_SO00	18	40	P11	RL78_SI00
19	41	P10	RL78_SCK00	20	-		No connection
21	61	P01	RL78_P01	22	62	P00	RL78_P00
23	63	P141	RL78_P141	24	64	P140	RL78_P140
25	-		VDD	26	-		VDD
27	6	RESET	RL78_/RESET	28	9	P137	RL78_INTP0
29	21	P31	RL78_P31	30	24	P75	RL78_P75
31	25	P74	RL78_P74	32	26	P73	RL78_P73
33	4	P41	RL78_P41	34	30	P06	RL78_P06
35	31	P05	RL78_P05	36	57	P130	RL78_P130
37	17	P60	RL78_P60	38	18	P61	RL78_P61
39	19	P62	RL78_P62	40	20	P63	RL78_P63
41	33	P50	RL78_INTP1	42	34	P51	RL78_INTP2
43	-		D_GND	44	-		D_GND
45	-		D_GND	46	-		D_GND
47	-		D_GND	48	-		D_GND
49	-		D_GND	50	-		D_GND

Figure 2.23 Extended MCU I/F Connector Layout

3. Demonstration of Phototransistor Mounted on Board

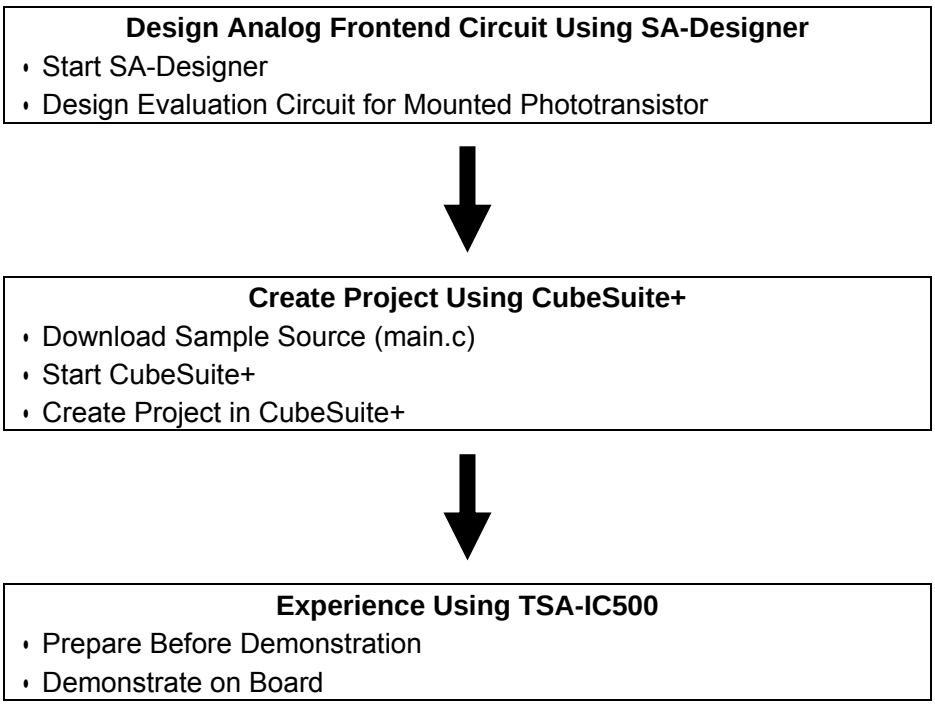
The tutorial will be describes in this section for customers to evaluate the design of analog frontend circuit. As the tutorial uses the phototransistor mounted on the board, customers can evaluate instantly. There are two ways to evaluate. Two tutorials will be explained in following order.

① Tutorial for SA-Designer and CubeSuite+
This is for those customers who have E1 emulator. Please download SA-Designer and CubeSuite+ from the Renesas Electronics web site.

3.1 Tutorial for SA-Designer and CubeSuite+

This section describes how to use SA-Designer and CubeSuite+ step by step. Please install SA-Designer and CubeSuite+ before stating this tutorial. The description assumes the PC is running Windows XP as the OS and the version of SA-Designer is “V1.01.00.08 [15 Oct 2012]” and CubeSuite+ is “V1.03.00 [11 Oct 2012]”. For details about functions and operations of SA-Designer and CubeSuite+, please refer to the help function.
If you want to use other IDE, please get support for Renesas Electronics.

Tutorial Steps



3.1.1 Design Analog Frontend Circuit Using SA-Designer

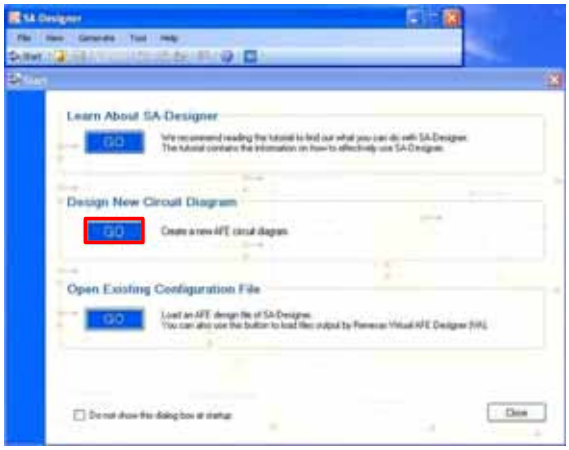
3.1.1.1 Start SA-Designer

Start SA-Designer. When SA-Designer started, below window will open.

3.1.1.2 Design Evaluation Circuit for Mounted Phototransistor

You are going to design an evaluation circuit for mounted phototransistor.

① Click “GO” button in “Design New Circuit Diagram”.

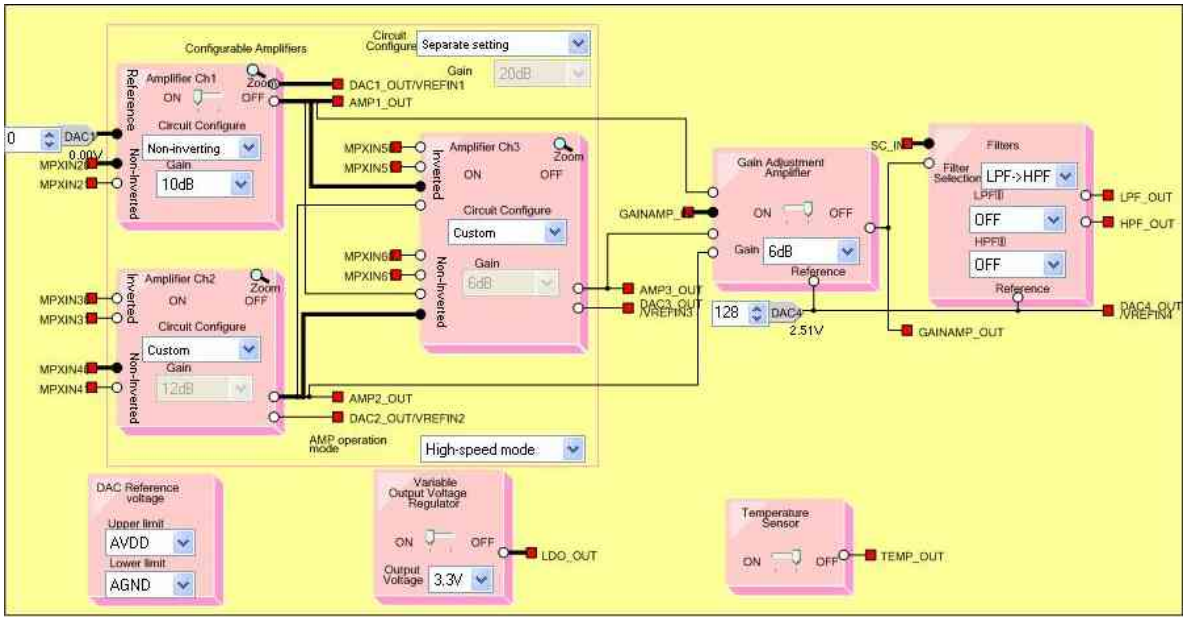


② Enter and set following information on the "New Creation" window.

- Device name: R5F10FME(Smart Analog MCU500) *
- Source generation path : (Wherever needed; for example, “AFE-PT”)
- Library: Check “Generate the SPI Function” and ” Generate the graph-analysis library”

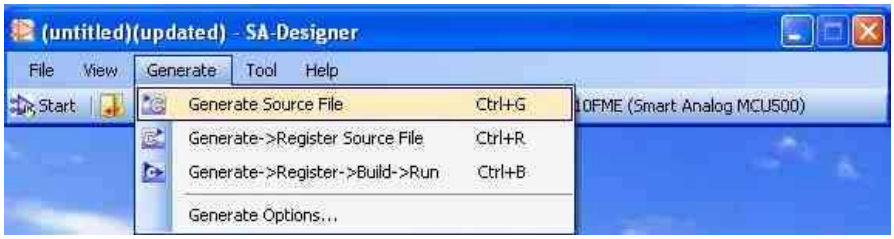
* Normally, it should be “RL78/G1A R5F10ELEAFB”, but the version 1.01 of SA-Designer does not support it. Therefore, select the RL78/G1E “R5F10FME (Smart Analog MCU500) ”. This device is a Smart Analog MCU packaging the CPU “RL78/G1A” and analog part “Smart Analog IC500”. So, the CPU is the same.

③ Design an analog frontend circuit to use the phototransistor. Change the setting from the initial status as shown below circuit diagram.

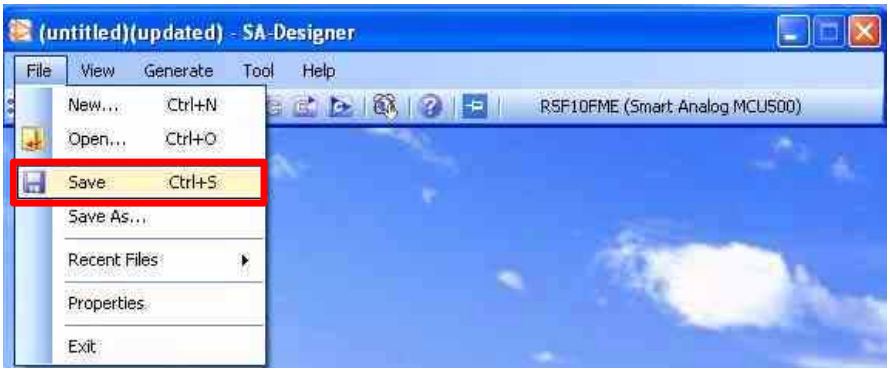


* Caution:
Use the fixed voltage 3.3V for the adjustable output voltage regulator (LDO_OUT). RL78/G1A does not support voltage other than 3.3V.

④ Generate sources by clicking “Generate” on the menu bar, then click “Generate Source file”. It generates C source code reflecting the circuit design result.



⑤ Save the design file by clicking "File" on the menu bar, then click "Save". It saves the circuit design result.



- File name: (Wherever needed; for example, "AFE-PT.ini")
- Creator: (Whoever needed)
- Description: (Whatever needed)

3.1.2 Create Project Using CubeSuite+

This section explains about starting CubeSuite+ and creating a new project.

3.1.2.1 Download Sample Program (main.c)

Download the sample program (main.c) from the web site below, and save it in the folder created with SA-Designer.

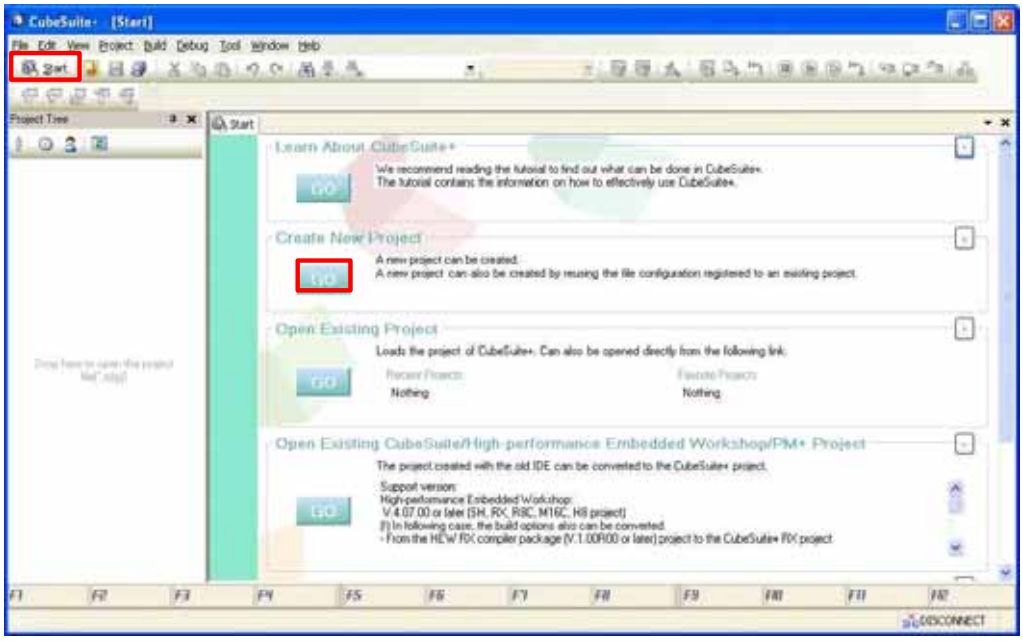
Currently, sample programs are provided with the user's manual. Web site is under construction.

3.1.2.2 Start CubeSuite+

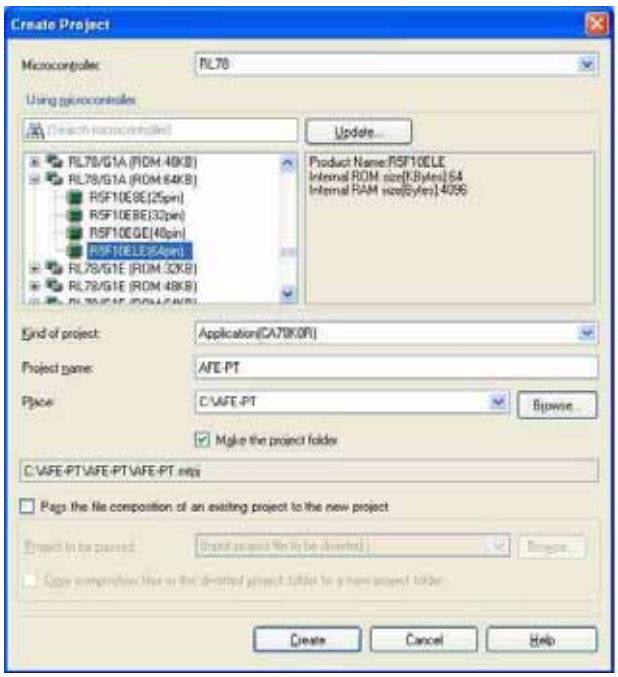
Start CubeSuite+. Click “Tool” on the menu bar, and then select “Startup IDE”. CubeSuite+ will launch. CubeSuite+ can be launched from Windows Start menu.

3.1.2.3 Create Project in CubeSuite+

① Open the menu by clicking “Start” button after CubeSuite+ starts. Click “GO” button in the “Create New Project” area.

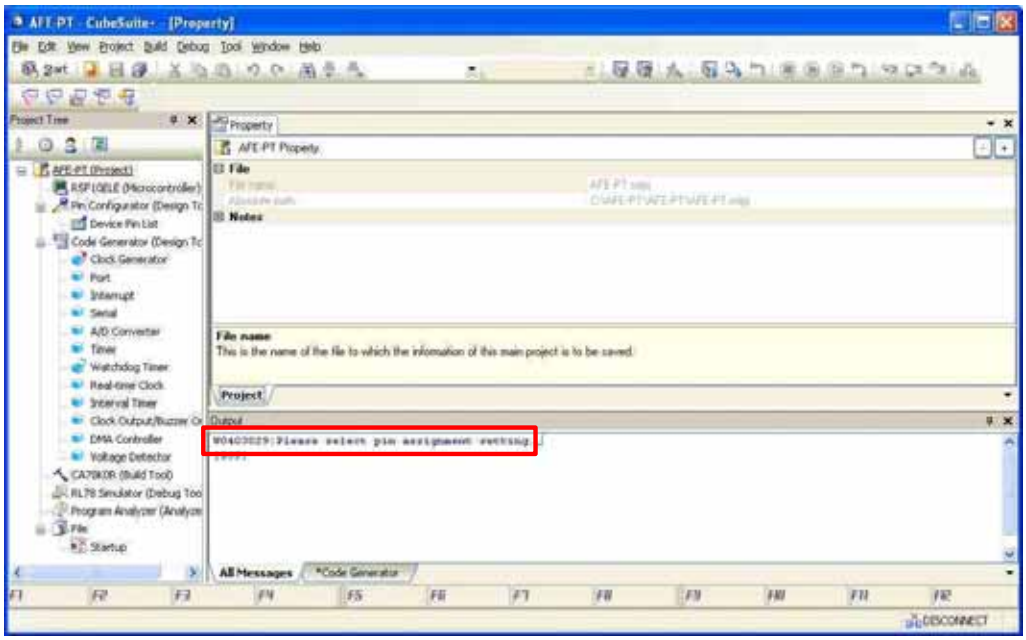


② Set following information on the "Create Project" window.

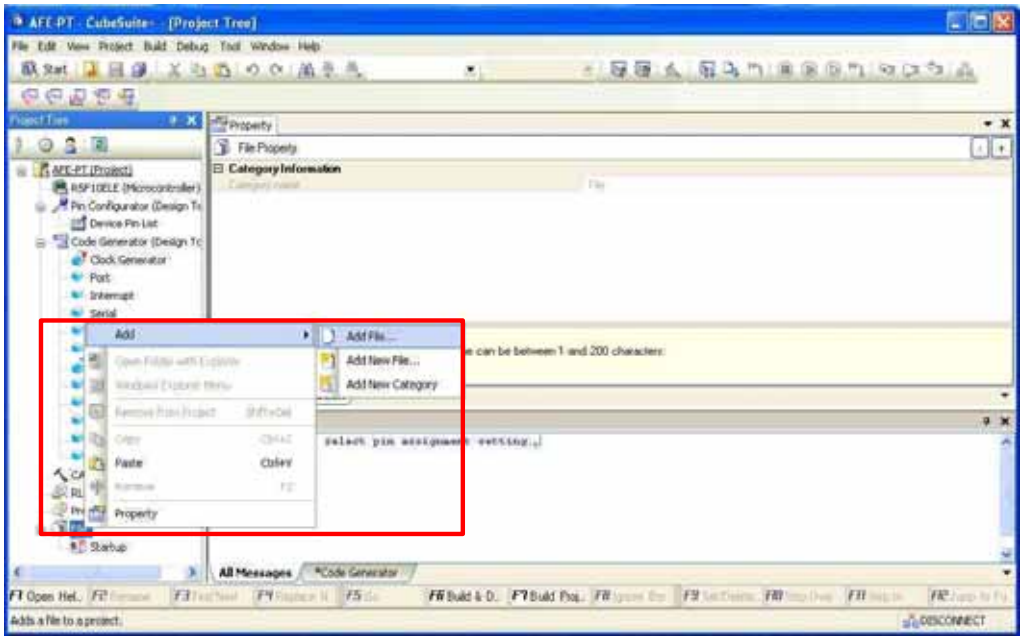


- Microcontroller: RL78
- Using microcontroller: R5F10ELE(RL78/G1A/ROM64KB/64pin)
- Kind of project: Application (CA78K0R)
- Project name: (Whatever needed; for example, "AFE-PT")
- Place: (The folder created with SA-Designer)

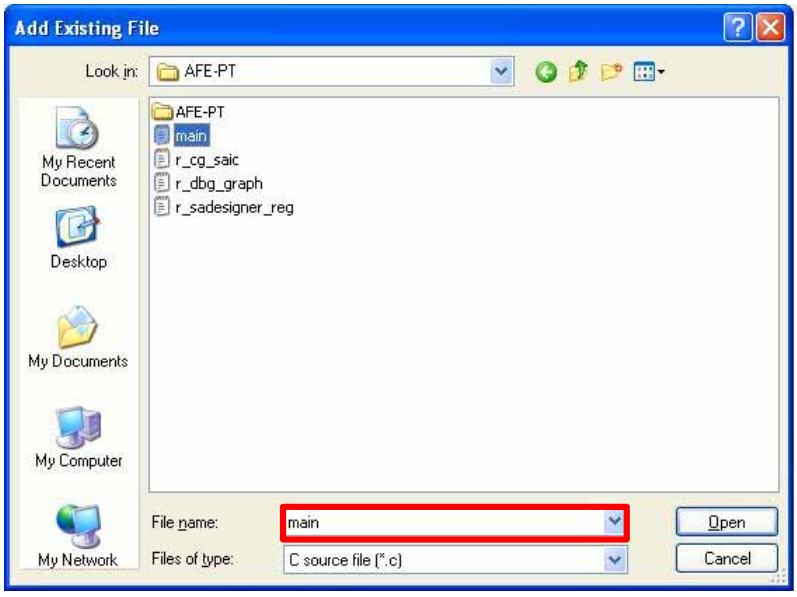
It would outputs a warning message regarding code generation. However, the operations in this user's manual will not use the code generation. So, you can ignore it.



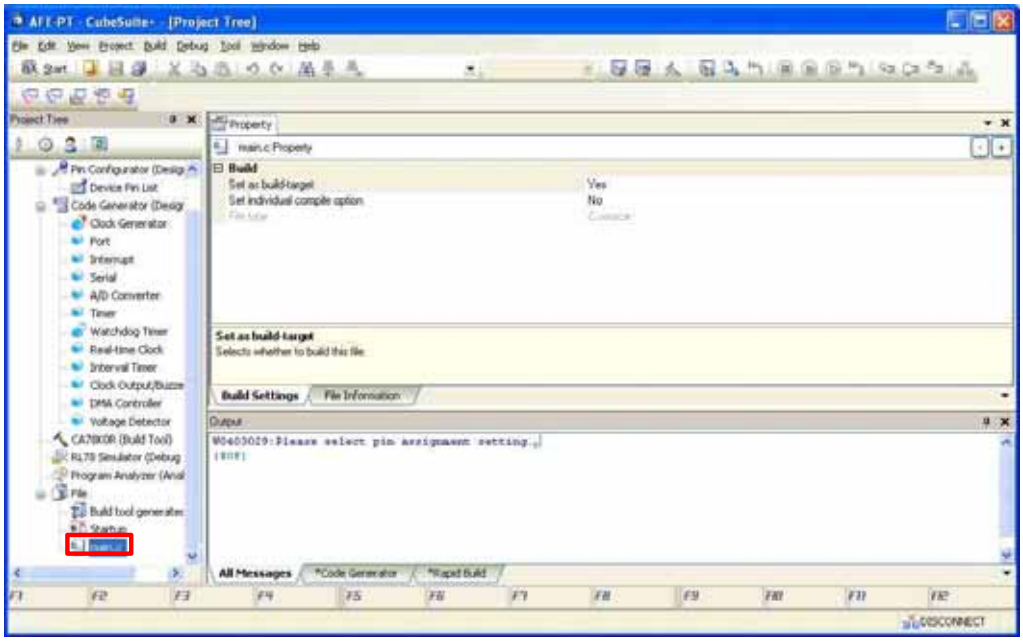
③ Select “File”, “Add”, and then “Add File”.



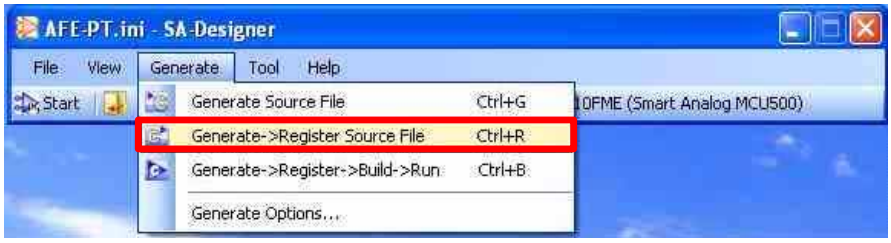
④ Select “main.c”, and then click “Open”.



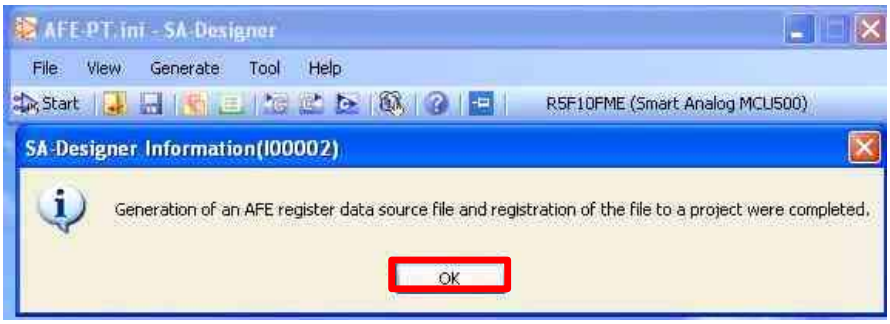
⑤ Confirm the “main.c” is added under “File”.



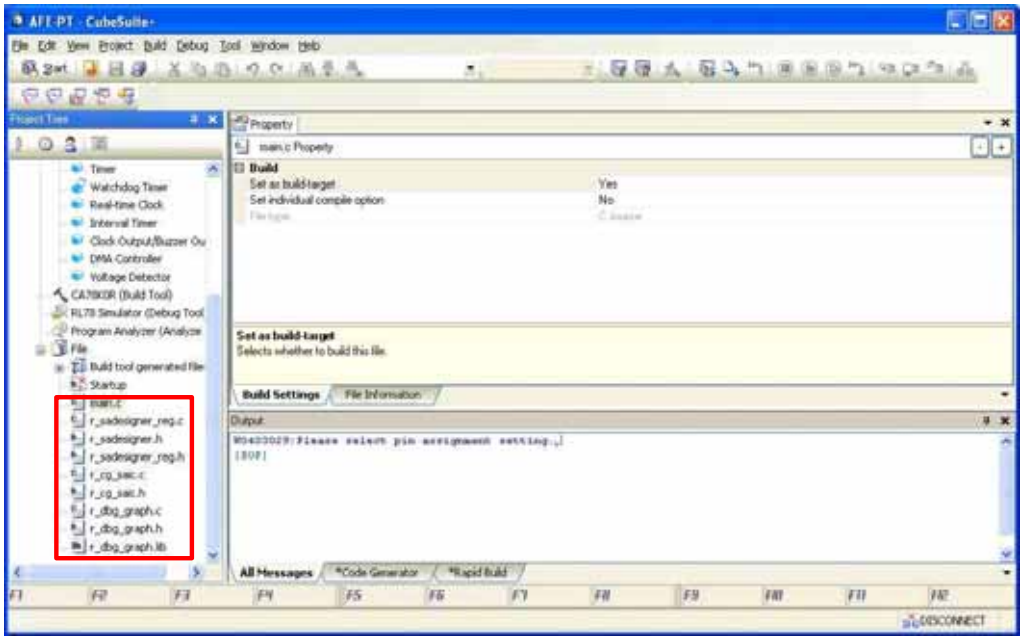
⑥ **Now switching the operation to SA-Designer.** Switch to SA-Designer.
Select “Generate” on the menu bar, and then select “Generate->Register Source File”.



⑦ When the registration completes, the following window displays. Click “OK”.

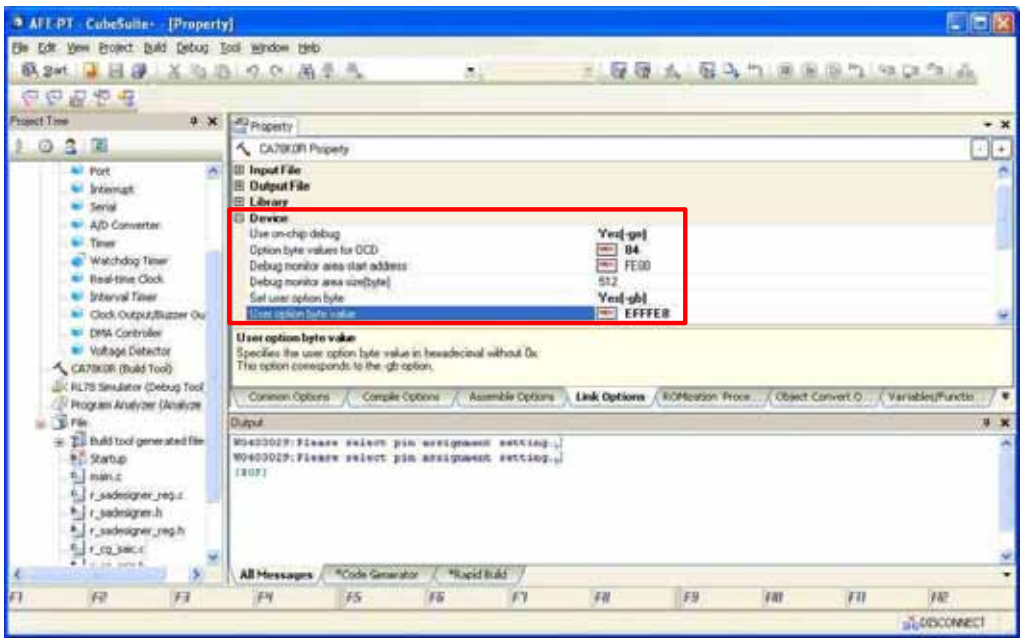


⑧ **Now switching the operation to CubeSuite+.** Switch to CubeSuite+.
Confirm the sources generated with SA-Designer are added under “File”.



Following sources will be added under “File”:
r_sadesigner_reg.c
r_sadesigner.h
r_sadesigner_reg.h
r_cg_saic.c
r_cg_saic.h
r_dbg_graph.c
r_dbg_graph.h
r_dbg_graph.lib

⑨ Go to “CA78K0R (Build Tool)”, “Link Option”, “Device”, and then set the following information.



- Use on-chip debug: Yes(-go)
- Option byte values for OCD: 84
- Set user option byte: Yes(-gb)
- User option byte values: EFFFE8

Click the red-framed button below to rebuild.

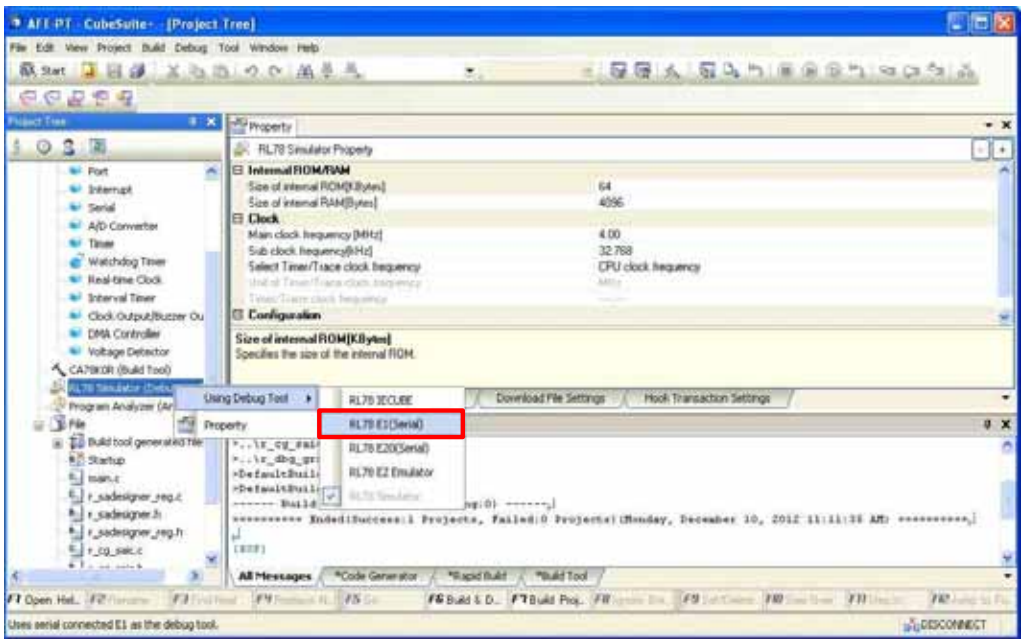
3.1.3 Experience Using TSA-IC500

This section explains how to demonstrate with TSA-IC500.

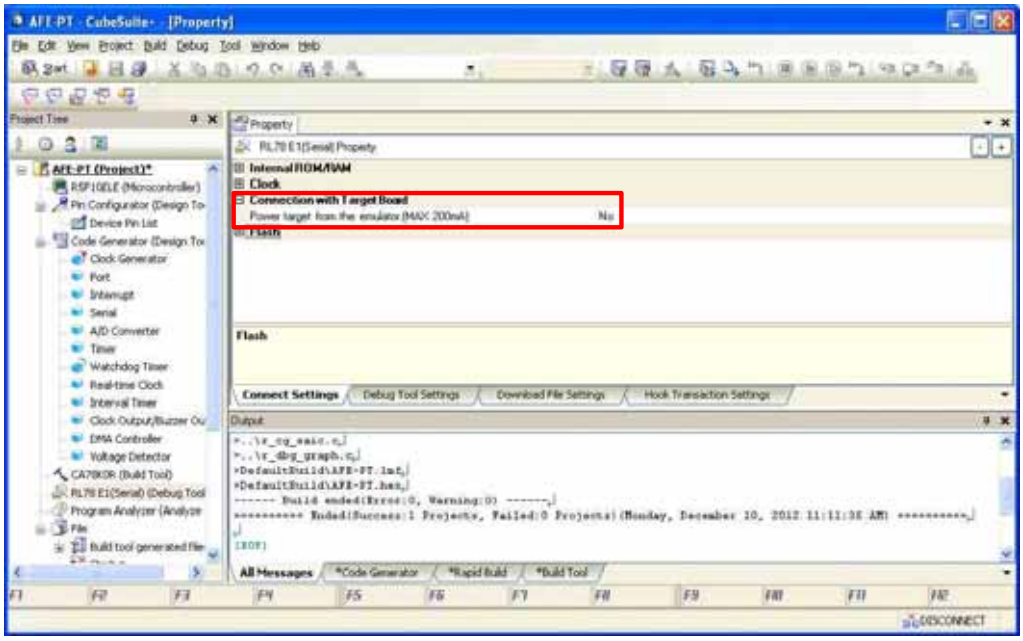
3.1.3.1 Prepare Before Demonstration

Preparation before checking the operation is explained.

① Change the debug tool to “RL78 E1(Serial)(L)”.

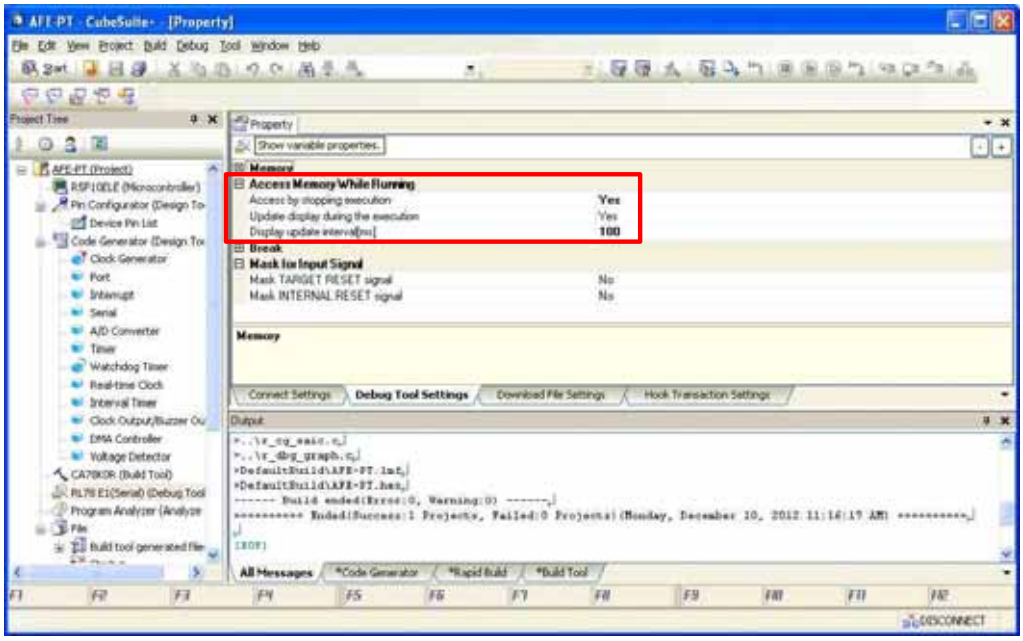


② Confirm “Power target from the emulator[MAX 200mA]” is set to “No”.



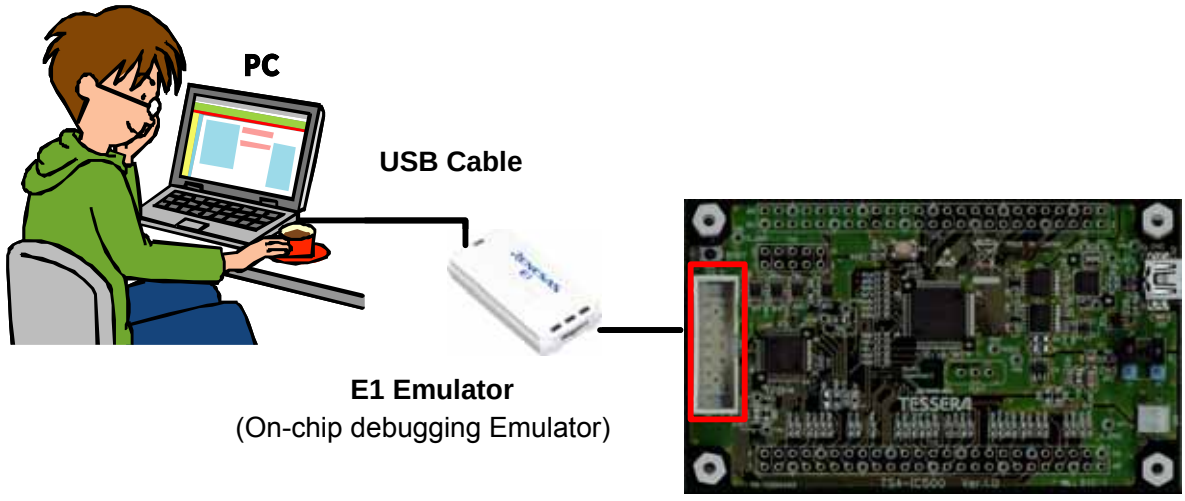
* Caution:
Do not supply power from E1 emulator.

③ Go to “Debug Tool Settings” and set following information for “Access Memory While Running”.

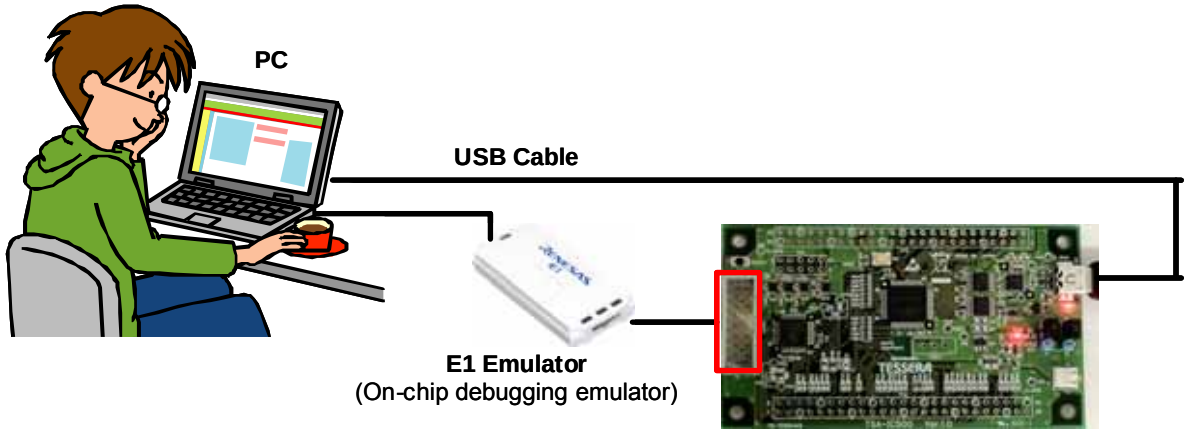


- Access by stopping execution: Yes
- Display update interval [ms]: 100

④ Connect E1 emulator to E1 emulator I/F connector of TSA-IC500.



⑤ Connect TSA-IC500 to PC with USB cable for supplying power. Alternatively, external power supply can be used with changing the JP1 setting. Confirm that the LED turns on.



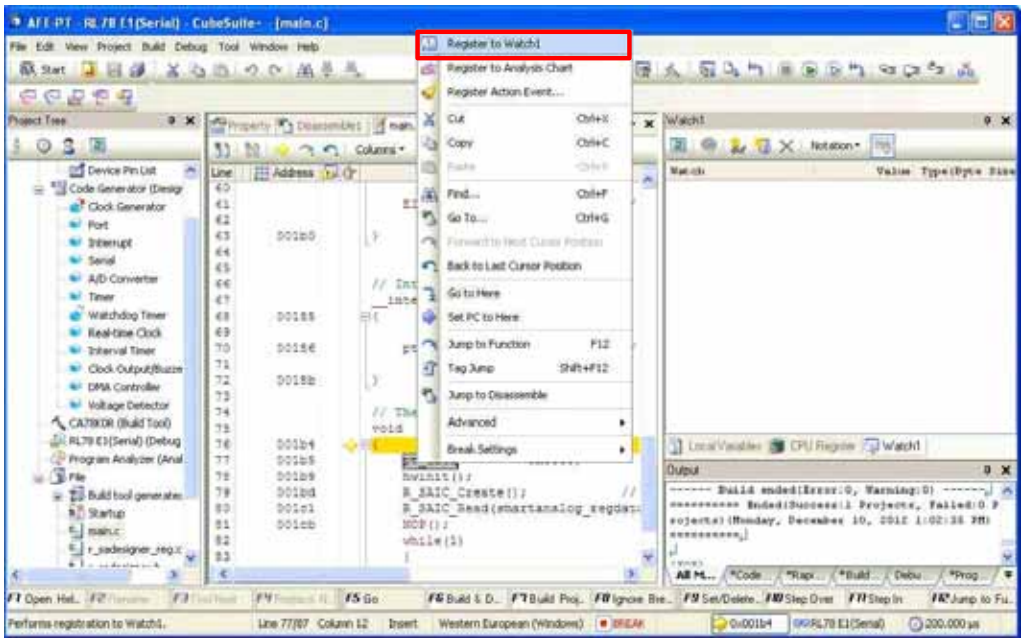
If "Found New Hardware Wizard" displays, please ignore it. Only do the power supply.

3.1.3.2 Demonstrate on Board

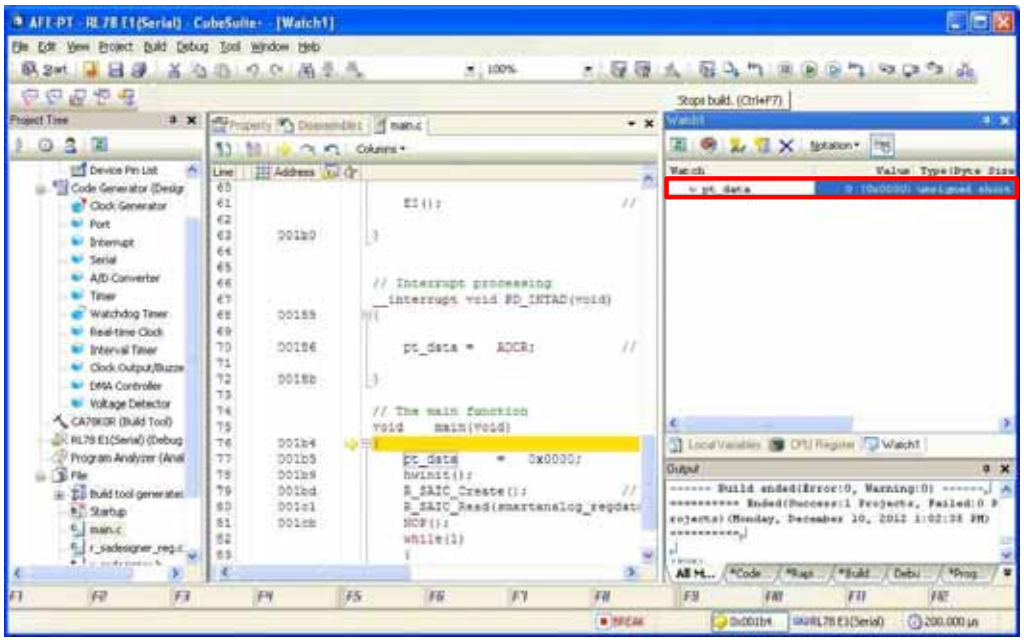
Checking the operation on the board is explained.

① Click the red-framed button below to download.

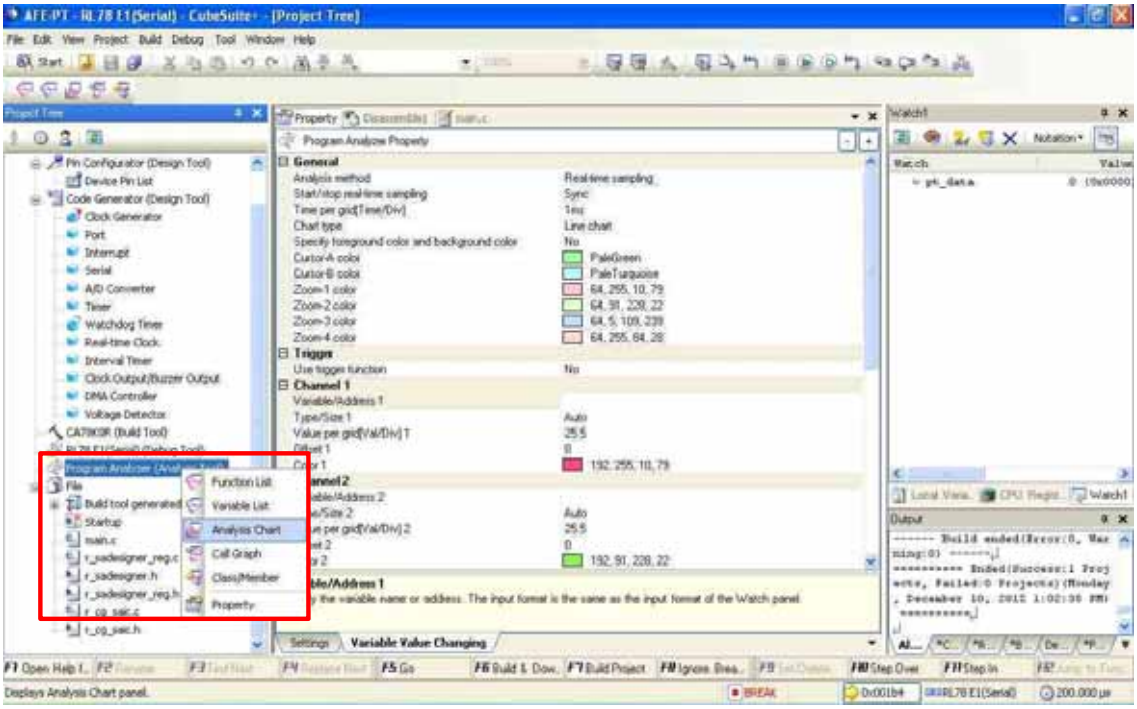
② Select the variable pt_data that is a variable displaying in graph, and then click “Register to Watch1”.



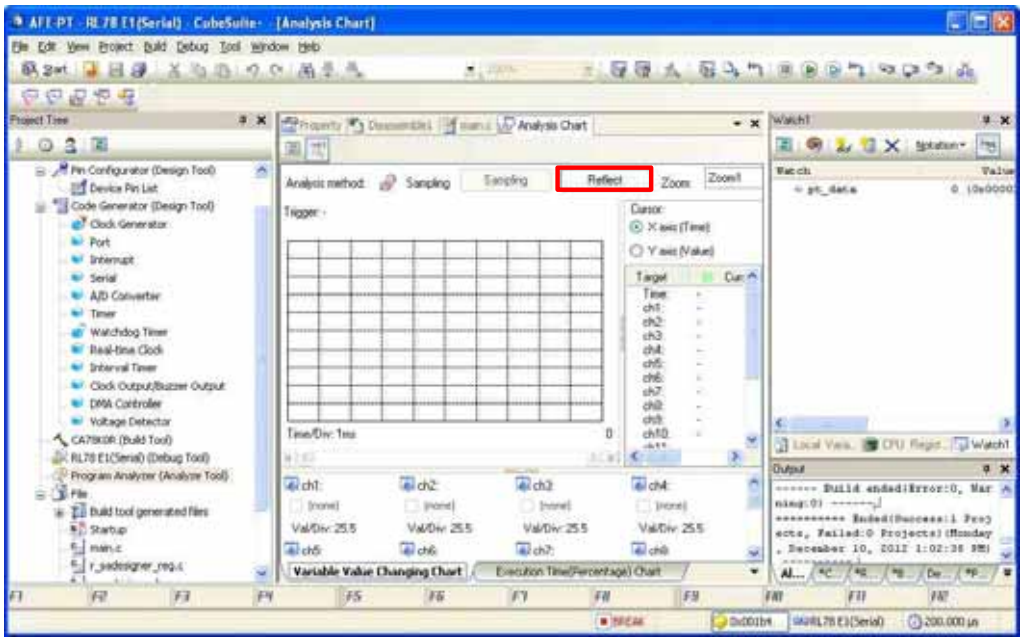
③ Confirm the variable pt_data is registered to "Watch1".



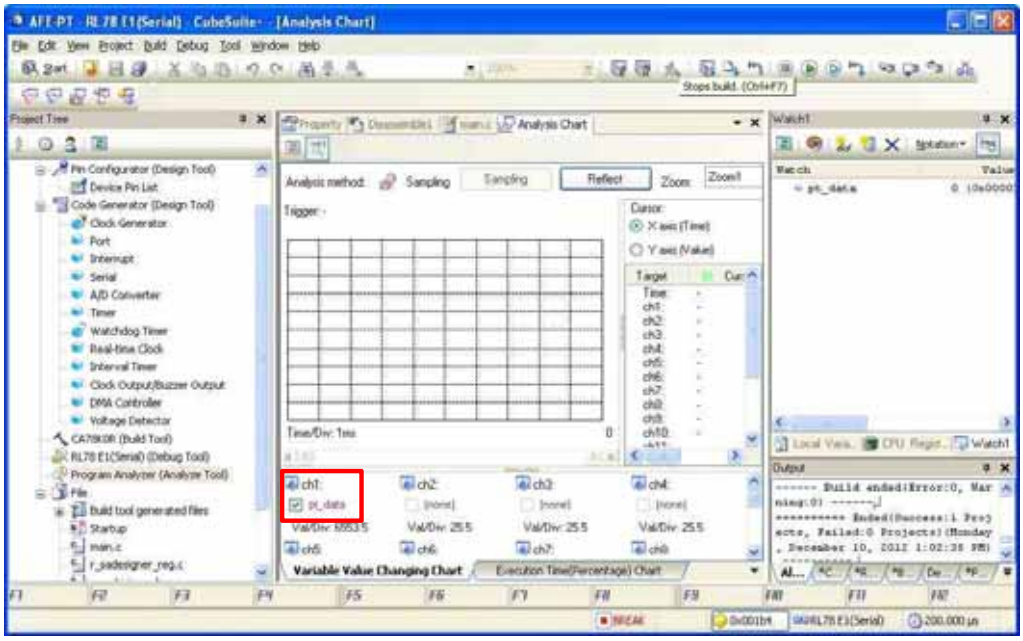
④ Click “Analysis Chart” from "Program Analyzer".



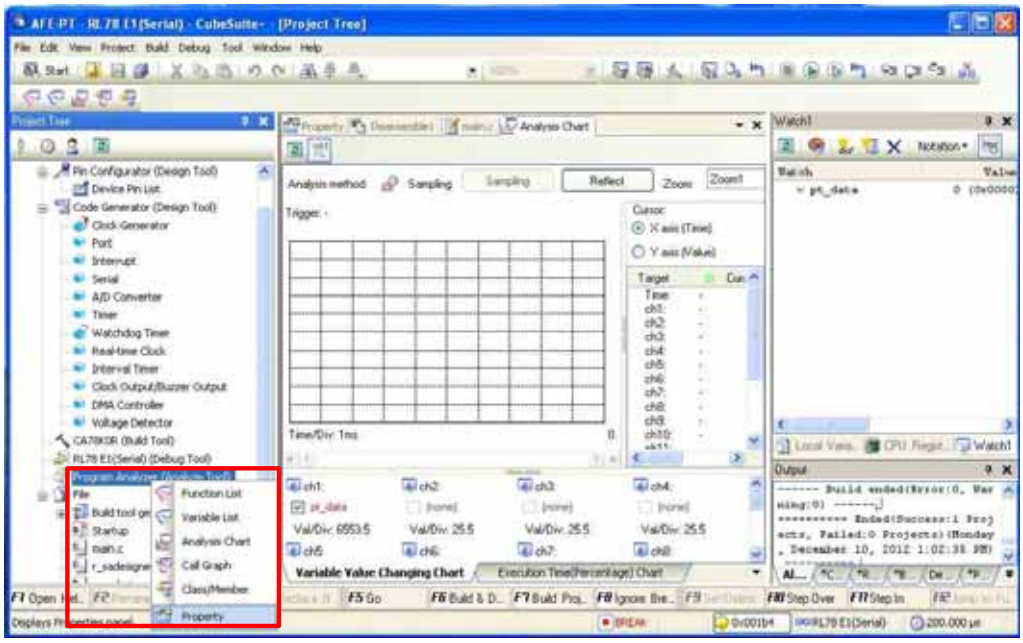
⑤ Click “Reflect” button in “Analysis Chart”



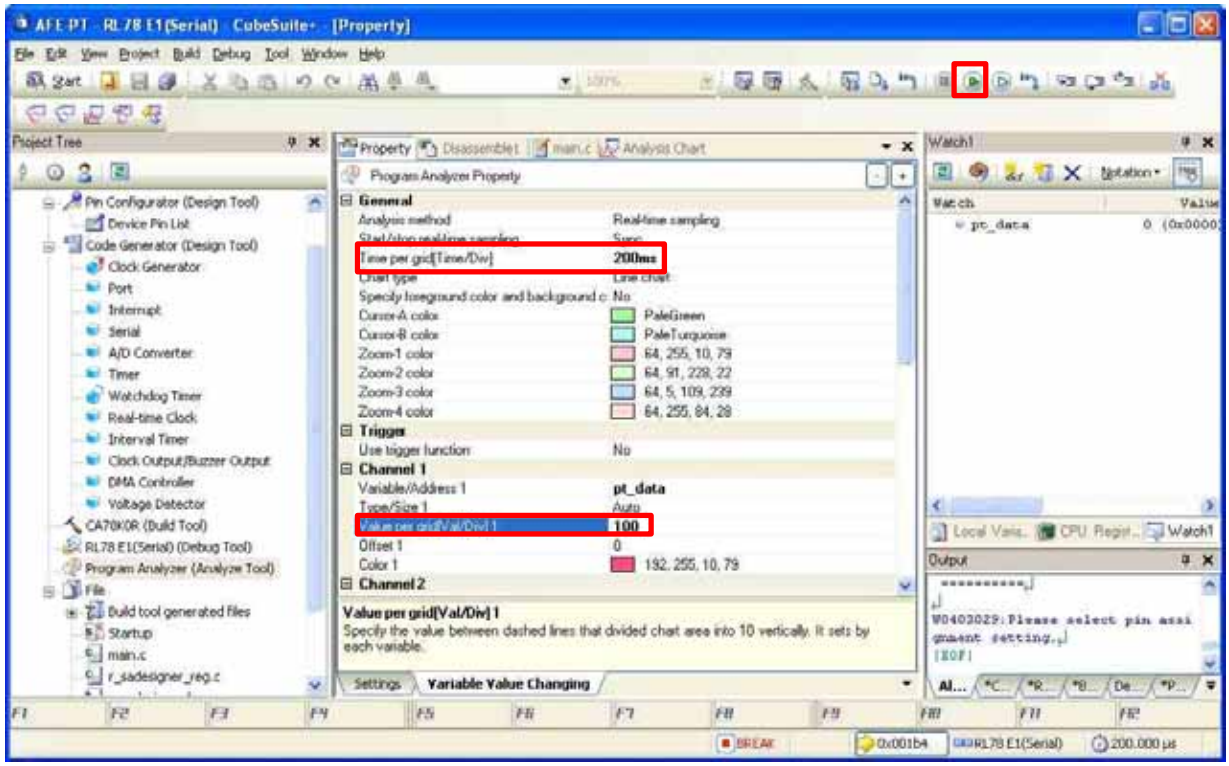
⑥ Confirm the variable pt_data is registered to " ch1"



⑦ Click “Property” from “Program Analyzer”.



⑧ Set values shown below, and click “Execute” button.
Click “Analysis Chart” when executed.



- Time per grid[Time/Div]: 200ms
- Value per grid[Val/Div]: 100

⑨ Try and see the value changes of variable according to the illuminance level.

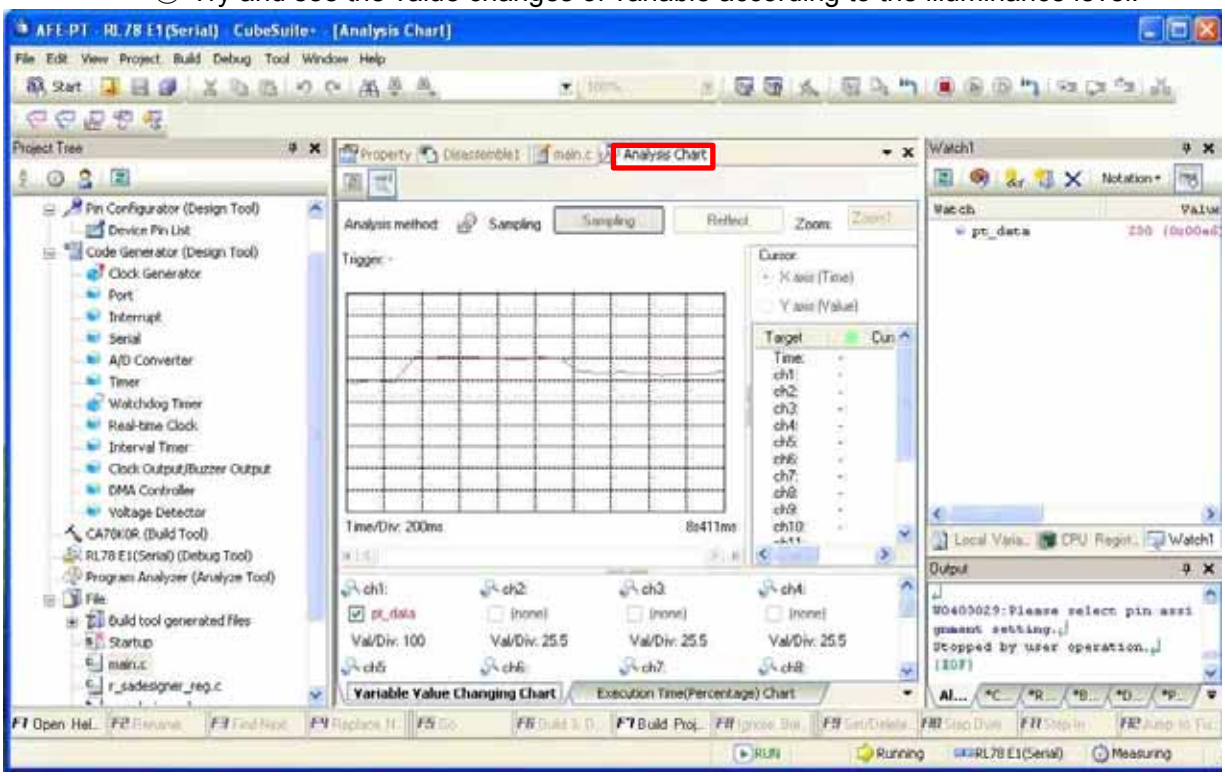
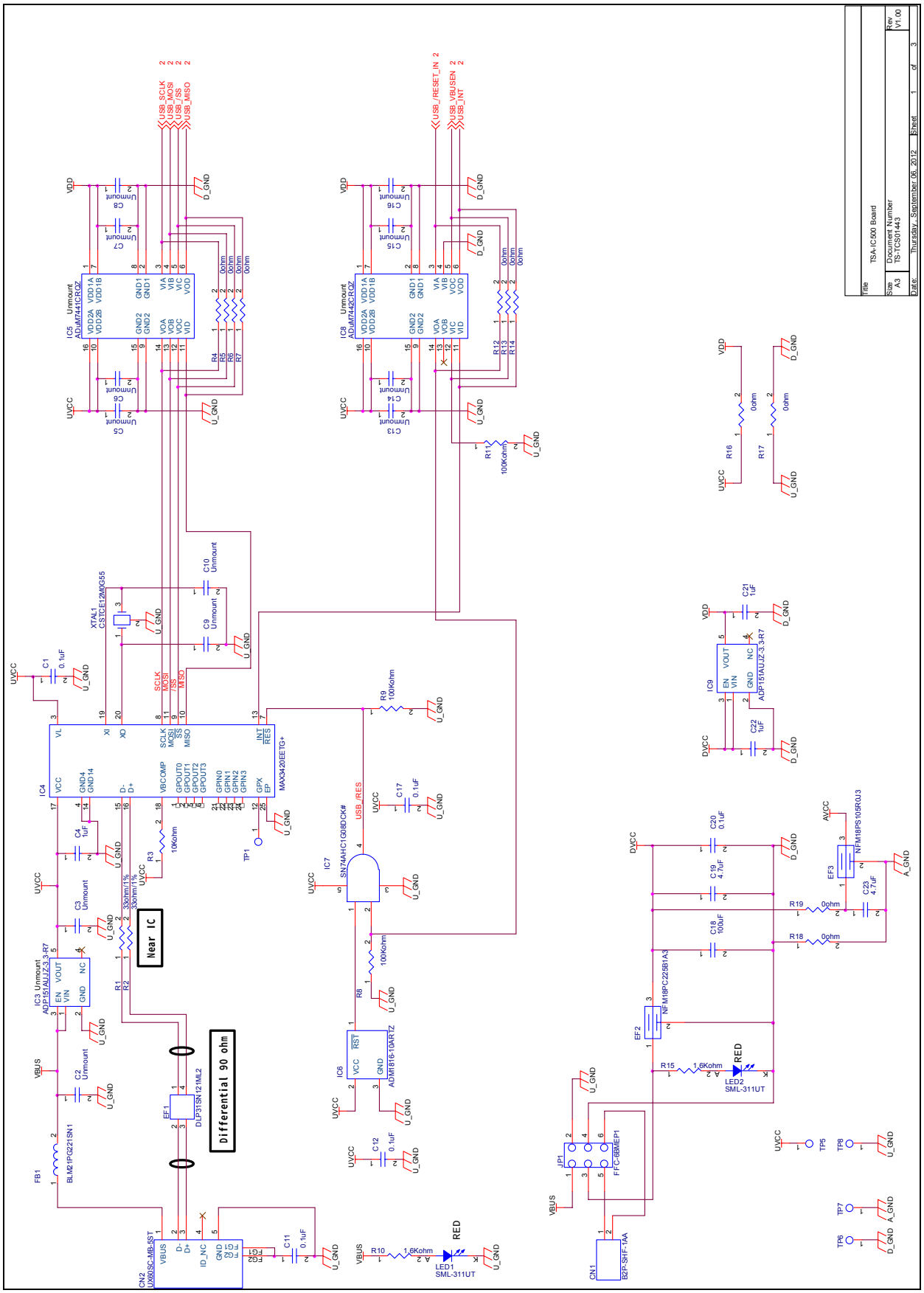


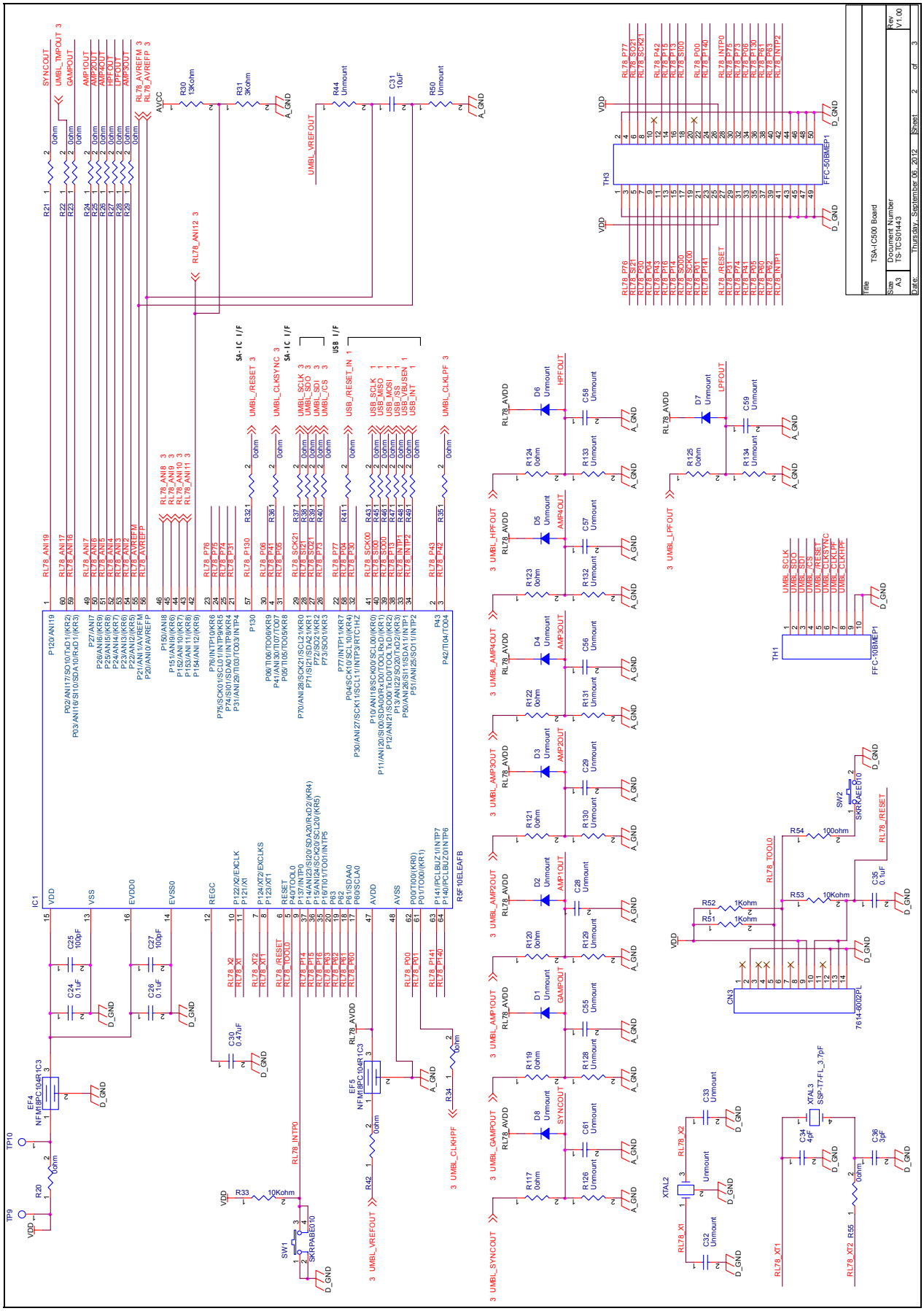
Figure 3.1 Phototransistor Position

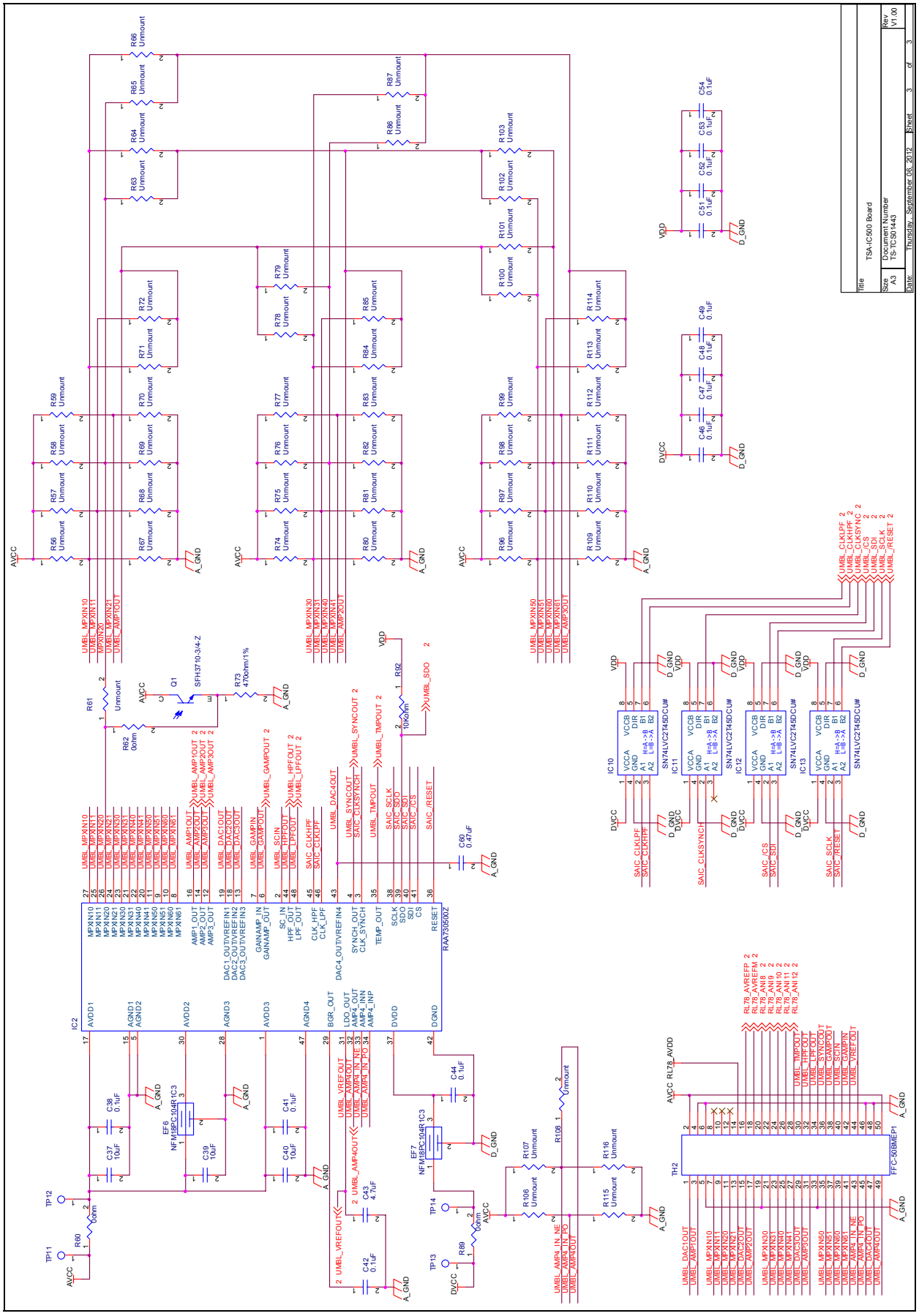
4. Hardware Materials

4.1 Circuit Diagrams

The circuit diagrams are described in the following pages.


Near IC
Differential 90 ohm
MAX3420EETG+
SN74AHC1G08DCK#
ADM6316-10ART2
ADP151AUJZ-3.3-R7
ADP155AUJZ-3.3-R7
DLP31SN121ML2
BLM21PG221SN1
NFM18PS105R0J3
NFM18PC225B1A3
B2P-SHF-1AA
FFC-68MEP1
SML-311UT
LED1
LED2
RED
Title
TSA-IC500 Board
Document Number
TS-TC501443
Rev
V1.00
Size
A3
Date:
Thursday, September 06, 2012
Sheet
1
of
3





4.2 Parts List

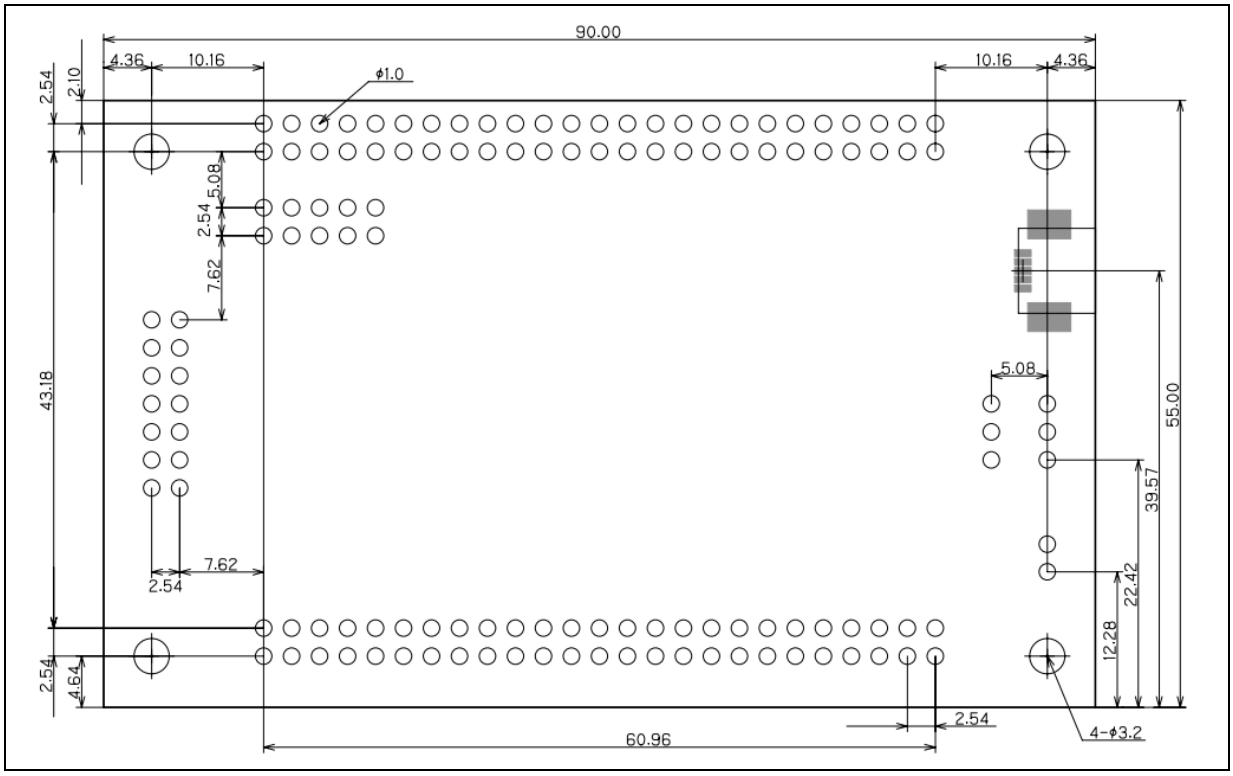
The parts information is listed in the following page.

TSA-IC500 Parts List Version 1.0

Item	Quantity	Reference(Mount Parts)	Reference(Unmount Parts)	Part Name	Part Kind	Part Model Number	Maker	Memo
1	1	CN1		B2P-SHF-1AA	Connector	B2P-SHF-1AA	JST	
2	1	CN2		UX60SC-MB-5ST	Connector	UX60SC-MB-5ST	HIROSE	
3	1	CN3		7614-6002PL	Connector	7614-6002PL	3M	
4	20	C1,C11,C12,	C5,C6,C7,C8,C13,C14,C15,C16	0.1uF	Ceramic Capacitor	GRM188R71H104KA93#	Murata	
		C17,C20,						
		C24,C26,C35,C38,C41,C42,						
		C44,C46,C47,C48,C49,						
		C51,C52,C53,C54						
5	3	C4,C21,C22	C2,C3	1uF	Ceramic Capacitor	GRM21BB11C105KA01#	Murata	
6	0		C9,C10,C28,C29,C32,C33,C55,C56,C57,C58,C59,C61	Unmount(C1608)	Ceramic Capacitor	1608 Size	-	
7	1	C18		100uF	Ceramic Capacitor	GRM31CR60J107ME39#	Murata	
8	3	C19,C23,C43		4.7uF	Ceramic Capacitor	GRM21BB31E475KA75#	Murata	
9	2	C25,C27		100pF	Ceramic Capacitor	GRM1882C1H101JA01#	Murata	
10	2	C30,C60		0.47uF	Ceramic Capacitor	GRM188B31E474KA75#	Murata	
11	4	C31,C37,C39,C40		10uF	Ceramic Capacitor	GRM21BR61C106KE15#	Murata	
12	1	C34		4pF	Ceramic Capacitor	GRM1882C1H4R0CZ01#	Murata	
13	1	C36		3pF	Ceramic Capacitor	GRM1883C1H3R0CZ01#	Murata	
14	0		D1,D2,D3,D4,D5,D6,D7,D8	1SS389	Diode	1SS389	TOSHIBA	
15	1	EF1		DLP31SN121ML2	Filter	DLP31SN121ML2	Murata	
16	1	EF2		NFM18PC225B1A3	Filter	NFM18PC225B1A3	Murata	
17	1	EF3		NFM18PS105R0J3	Filter	NFM18PS105R0J3	Murata	
18	4	EF4,EF5,EF6,EF7		NFM18PC104R1C3	Filter	NFM18PC104R1C3	Murata	
19	1	FB1		BLM21PG221SN1	Filter	BLM21PG221SN1	Murata	
20	1	IC1		R5F10ELEAFB	IC	R5F10ELEAFB	Renesas	
21	1	IC2		RAA730500D	IC	RAA730500DFP	Renesas	
22	1	IC9	IC3	ADP151AUJZ-3.3-R7	Regulator	ADP151AUJZ-3.3-R7	AnalogDevices	
23	1	IC4		MAX3420EETG+	IC	MAX3420EETG+	MAXIM	
24	0		IC5	ADuM7441CRQZ	Isolator	ADuM7441CRQZ	AnalogDevices	
25	1	IC6		ADM1816-10ARTZ	IC	ADM1816-10ARTZ	AnalogDevices	
26	1	IC7		SN74AHC1G08DCK#	IC	SN74AHC1G08DCK#	TI	
27	0		IC8	ADuM7442CRQZ	Isolator	ADuM7442CRQZ	AnalogDevices	
28	4	IC10,IC11,IC12,IC13		SN74LVC2T45DCU#	Voltage Level Shifter	SN74LVC2T45DCU#	TI	
29	1	JP1		FFC-3AMEP1x2	Jumper	FFC-3AMEP1x2	HONDA TSUSHIN	
30	2	LED2,LED1		SML-311UT	LED	SML-311UT	ROHM	
31	1	Q1		SFH3710-3/4-Z	Phototransistor	SFH3710-3/4-Z	OSRAM	
32	2	R1,R2		33ohm/1%	Resistance	RK73H1JTTD33R0F	KOA	
33	4	R3,R33,R53,R92		10Kohm	Resistance	RK73B1JTTD103J	KOA	
34	0		R56,R57,R58,R59,R63,R64,	Unmount(R1608)	Resistance	1608 Size	-	
			R65,R66,R67,R68,R69,R70,					
			R71,R72,R74,R75,R76,R77,					
			R78,R79,R80,R81,R82,R83,					
			R84,R85,R86,R87,R96,R97,					
			R98,R99,R100,R101,R102,					
			R103,R106,R107,R108,R109,					
			R110,R111,R112,R113,R114,					
			R115,R116,R126,R128,R129,R130,R131,R132,R133,R134					
35	3	R8,R9,R11		100Kohm	Resistance	RK73B1JTTD104J	KOA	
36	2	R15,R10		1.6Kohm	Resistance	RK73B1JTTD162J	KOA	
37	0		R44,R50,R61	Unmount(R2125)	Resistance	2125 Size	-	
38	9	R18,R19,R20,R42,R60,R62,		0ohm(R2125)	Resistance	RK73Z2ATTD	KOA	
		R89,R16,R17						
39	40	R21,R22,R23,R24,R25,R26,		0ohm(R1608)	Resistance	RK73Z1JTTD	KOA	
		R27,R28,R29,R32,R34,R35,						
		R36,R37,R38,R39,R40,R41,						
		R43,R45,R46,R47,R48,R49,						
		R55,R117,R119,R120,R121,R122,R123,R124,R125,						
		R4,R5,R6,R7,R12,R13,R14						
40	1	R30		13Kohm	Resistance	RK73B1JTTD133J	KOA	
41	1	R31		3Kohm	Resistance	RK73B1JTTD302J	KOA	
42	2	R52,R51		1Kohm	Resistance	RK73B1JTTD102J	KOA	
43	1	R54		100ohm	Resistance	RK73B1JTTD101J	KOA	
44	1	R73		470ohm/1%	Resistance	RK73H1JTTD4700F	KOA	
45	1	SW1		SKRPABE010	Switch	SKRPABE010	ALPS	
46	1	SW2		SKRKAEE010	Switch	SKRKAEE010	ALPS	
47	0		TH1	FFC-10BMEP1	Pin Header	FFC-10BMEP1	HONDA TSUSHIN	
48	0		TH3,TH2	FFC-50BMEP1	Pin Header	FFC-50BMEP1	HONDA TSUSHIN	
49	0		TP1,TP5,TP6,TP7,TP8,	TPD10	Test Point	φ1.0mm Through Hole	-	
			TP9,TP10,TP11,TP12,TP13,TP14					
50	1	XTAL1		CSTCE12M0G55	CERALOCK	CSTCE12M0G55	Murata	
51	0		XTAL2	Unmount(XTAL)	Oscillator	G1A_XTAL	-	
52	1	XTAL3		SSP-T7-FL_3.7pF	Resonator	SSP-T7-FL_3.7pF	SII	

4.3 Board Size

Figure 4.1 shows the board size and the position of connectors. The through-holes for extended terminals are placed with 2.54mm-pitch.



All linear dimensions are in millimeters.

Figure 4.1 Board Size

4.4 Parts Layout

Figure 4.2 shows the parts layout on the front side of the board, and Figure 4.3 shows the parts layout on the back side. For those references and part numbers of each part, please refer to the circuit diagram and parts list.

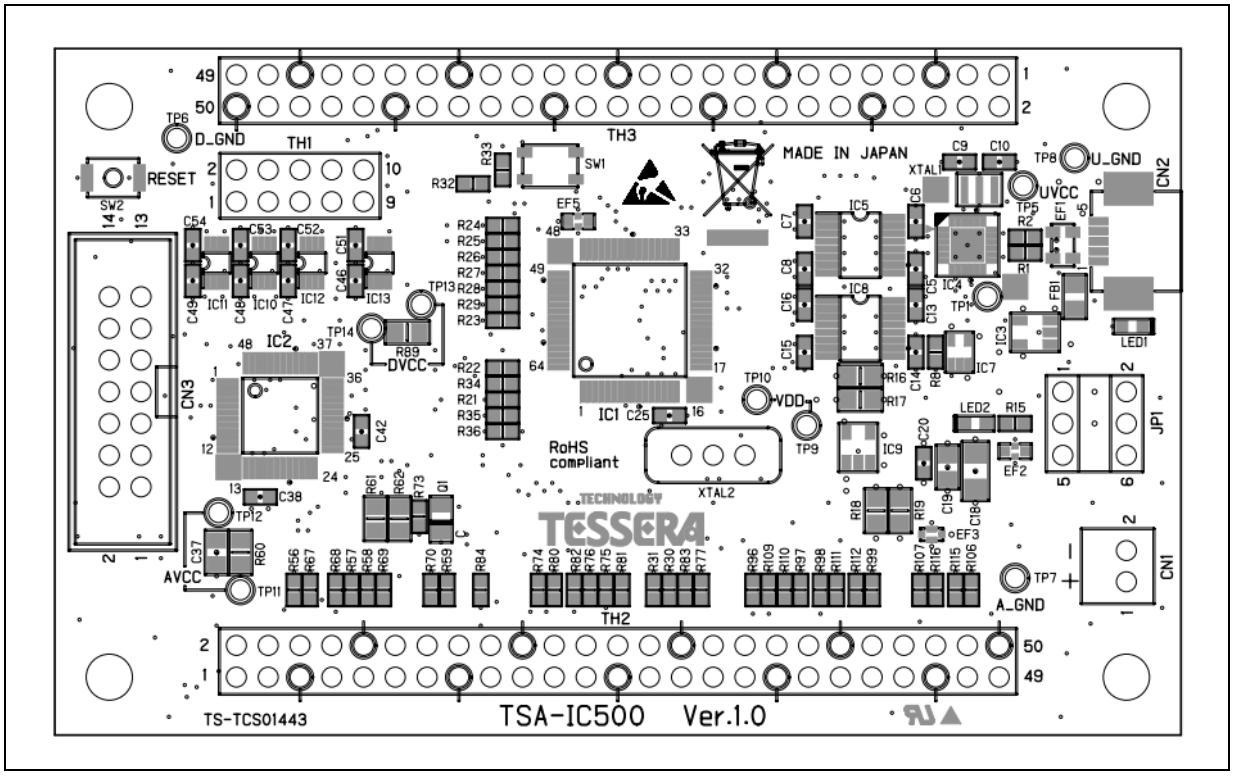


Figure 4.2 Parts Layout (front side)

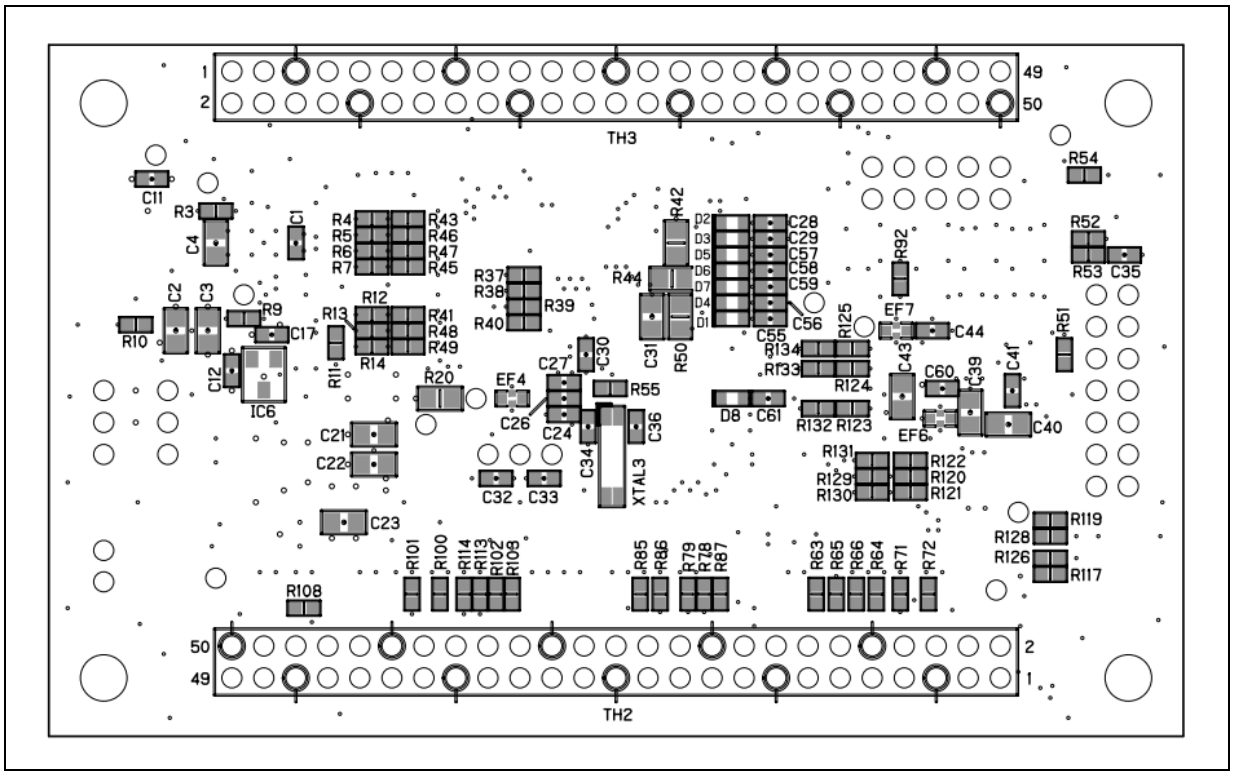


Figure 4.3 Parts Layout (back side)